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CONTENTS.

EDITORIAL:
High-Speed Railway Tests . . . 113
The Properties of Radium Emanations . . . 113
The Speed of the Recording Wattmeter . . . 114
The Age of Science . . . 114
The Age of Science, by Dr. Ira Remsen . . . 115
Methods of Loading Machines for Testing Purposes—Suppiying only the Losses, by E. A. Regestein . . . 117
Educational Exhibits in the Palace of Electricity . . . 121
A New Westchester Lighting Company . . . 124
High-Speed Electric Railway Experiments on the Marienfelde-Zossen Line, by Alexander Siemens . . . 124
The Testing of Meters for a Central Station Meter Department . . . 129
Parsons & Stoney's Continuous-Current Dynamos . . . 130
Electrical Industries in England . . . 130
Improving Electric Lighting Service . . . 131
Magnetism and Planetary Bodies . . . 131
An Arc Lamp for Amateurs . . . 131
Commercial Practicability of Electric Traction by Surface Contacts . . . 132
Electrical Patents . . . 133
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE . . . 134
INDUSTRIAL SECTION:
Slow-Speed Motors for Direct Current . . . 136
Forms of Turbines Most Suitable for Low Falls . . . 138
Industrial Education in Germany . . . 138
The Extra Service of the Large Allis-Chalmers Engine at the World's Fair . . . 138
Electrical Locomotives for Gathering Purposes . . . 139
Electric Vehicle Type Storage Batteries . . . 140
CURRENT ELECTRICAL NEWS . . . 141

THE GERMAN HIGH-SPEED RAILWAY TESTS.

We complete in this issue a very valuable paper read before the British Institution of Electrical Engineers by Mr. Alexander Siemens, upon the high-speed electric railway tests on the Marienfelde-Zossen experimental line. This paper gives a brief account of the historical side of this work, which, by the way, was conducted under very stringent rules formulated by the German government. It also gives the results of the trials, and shows how they may affect future practice. This work was carried out in the thorough manner so characteristic of the Germans, investigations being made not only of the electrical and steam equipment, but also of the track, the brakes, locomotive friction and air pressure. One of the interesting and not unexpected results obtained was the importance of air resistance. These experiments show that with the high speeds attained by the two electric cars, the effect of air resistance is by far the most important of the retarding influences, and that the train resistance formulæ in use at present are not applicable to such high speeds. The work has not yet been completed, but it is probable that it will be pushed further in the near future, both steam and electric traction receiving attention.

THE PROPERTIES OF RADIUM EMANATIONS.

An important investigation has been carried out by Sir William Ramsay, assisted by Mr. F. Soddy, with the object of isolating and studying the gas set free by radium salts, and known as the emanation. According to the disintegration theory, the emanation is only one stage in the breakup of the radium atoms; it is not matter in a permanent condition, as the emanation itself breaks up with radioactive phenomena, the final product being apparently the inert gas, helium.

Separation of the Emanation.

To separate this emanation from other matter, use was made of the action of radium bromide upon water. The latter is decomposed, if the salt be dissolved in it, oxygen and hydrogen being given off. This mixture of gases is explosive, though the hydrogen is slightly in excess of that required to combine with the oxygen for the formation of water. The mixture of gases thus obtained was ignited, and the products of the reaction placed in a liquid-air refrigerating apparatus. This enabled the excess of hydrogen to be drawn off, and upon allowing the vessel containing the emanation to become warm, it was found that a small quantity of gaseous emanation—about one-fiftieth of a cubic millimetre—had been collected. An examination of the physical properties of this gas showed that it followed the law of gases, the volume being inversely proportional to the pressure. This gas is luminous, and the spectrum was carefully examined; but by the end of a month the luminosity had died out. The emanation was then warmed and the pressure reduced. A gas was obtained which had four times the volume of the other, and which showed the characteristic spectrum of and was undoubtedly helium. The emanation itself seems to resemble the gases of the argon family. Sir William Ramsay suggests that as this emantion is really a gas, though not stable, that it be called *exradio*.

Commercial Transmutation Not Probable.

The supporters of the disintegration theory are not losing any time; they are adding daily to our knowledge of these new phenomena, and have already made a good start in the youngest branch of science, subatomic physics. There are also indications that the expected opposition of the chemists to the new theory will not be met, as a more careful examination of the new ideas shows that there is nothing which will upset the science of chemistry. The possibility of the transmutation of the elements has always been admitted, though the possibility

of accomplishing such changes seemed remote. The chemist still has his atoms and molecules, and we are not yet, nor are we soon, likely to be able to bring about transmutations at will. And even should we reach that stage, it is probable that the large quantities of energy required and the difficulty of controlling it would make the process too expensive to be commercially practical. Gold produced from copper in this way would undoubtedly cost several times as much as the natural metal.

THE SPEED OF THE RECORDING WATTMETER.

"Why is it that the speed of a Thomson recording wattmeter is proportional to the load?"

This question was one of those found in the question box of the recent convention of the National Electric Light Association. It elicited six replies, none of which answers the question satisfactorily, though four make a brave attempt to do so. These four show that the increase in the speed of the meter is due to an increase in the torque caused by a corresponding increase in the current passing through the fixed coil. This is true; but why does the same explanation not apply to a shunt motor, since so far as the winding of the meter is concerned, it is a shunt motor? Yet everyone knows that an increase in the field of the shunt motor causes a decrease of the speed; and it is doubtless this difference in the behavior of the two mechanisms which inspired the question.

The Motor.

Given a constant potential across the armature of a separately excited motor, its speed will be determined by three factors—the strength of the field, the load, and the armature resistance. We may, for the moment, leave out of consideration the number of conductors in the armature winding, since this is constant for any one machine. In the usual type of motor, the armature resistance is made small for several reasons, principally that the efficiency may be high, and also that the speed under varying loads may be fairly constant. It thus happens that the factors which control the speed are the field strength and load, the effect of the armature resistance usually being negligible. Assume, then, the machine to be at work, and suppose the field current to be increased, causing a corresponding increase in the magnetic field. The effect of this is to increase the counter electromotive force of the armature, and thus cause a decrease in the armature current. This decrease takes place at a greater rate than the increase in the field strength because the armature current is determined by the difference between the applied and the counter electromotive forces and not by the actual value of either. There has consequently been a decrease in the motor torque, which will cause the motor to slow down until the counter electromotive force has decreased sufficiently to allow the armature current to increase, and in this way bring back the torque to its original value, or to that value necessary to drive the machine at its decreased speed. In this readjustment the counter electromotive force is the controlling factor, the resistance playing a negligible part.

The Meter.

The Thomson meter, on the other hand, is almost the reverse of the ordinary motor. The current through its armature is intentionally controlled by the resistance of the armature circuit, which, of course, includes that of the armature proper and the auxiliary resistance. The field is weak and the speed comparatively slow, so that the counter electromotive force is negligible, this being the condition desired. Now, under these circumstances an increase in the strength of the field current, causing a corresponding increase in the magnetic field, increases the torque of the motor armature, without appreciably decreasing the armature current, since the counter electromotive force is so slight that its increase has no perceptible effect on the armature current.

The General Rule.

The motor must then speed up until the increase in the torque is balanced by a corresponding increase in the resistance to turning. These conditions do not apply merely to the Thomson meter motor, but they apply to any motor in which the field is so weak, or the speed so low, or the armature resistance so high, that the latter becomes the controlling factor in determining the armature speed. In fact, when the counter electromotive force is greater than the drop in potential due to the armature resistance an increase in the field causes a decrease in the speed; and, conversely, when the drop of potential due to the armature resistance is greater than the counter electromotive force an increase in the field causes an increase in the speed.

THE AGE OF SCIENCE.

One hears not infrequently the saying that this is the age of science, but seldom, if ever, does one see an attempt to justify this statement. On another page of this issue we publish an abstract of an address by Dr. Ira Remsen, president of Johns Hopkins University, which takes up this question. Dr. Remsen has always something interesting to say, and he is never more convincing than when he is pleading for the cause of science. Happily, to-day the value of pure scientific research is generally recognized, and this is particularly true as regards the engineering profession, the aim of which is to apply purely scientific discoveries to the benefit of mankind.

It is rather difficult to-day for the engineer to draw a hard and fast line between an art and a science. As Dr. Remsen puts it, "the object of an art is production; of a science, truth." But, in engineering, the production must always be based upon certain truths, and frequently these truths deserve to be classed as scientific discoveries, although they may have been brought to light in an investigation carried out for the purpose of aiding production. The engineer usually has an object in view in his studies, but there are not wanting some who follow science also for the love of science and as a recreation, not seeking for any reward. These facts, however, in no way contradict Dr. Remsen's contention, that the best scientific work is done by those who work because they love it, and who expect no reward for their labor. It is such men who make possible new arts, and no profession is more deeply indebted to such disinterested work than that of electrical engineering.

THE AGE OF SCIENCE.[1]

BY IRA A. REMSEN, PH. D.

As much of the time of those who go forth from this institution to-day has been spent in the study of the sciences, it has seemed to me fitting to ask your attention to some considerations suggested by the phrase, "this is the age of science." I do not remember ever to have heard this statement questioned, much less denied, nor do I remember ever to have heard it satisfactorily explained. It sounds simple enough, and does not appear to call for explanation or comment, and yet I think it worth while to examine it a little more carefully than is customary, to see in what sense it is true. For in a sense it is true, and in a sense it is not true. The statement raises two questions which should be answered at the outset. These are, first, what is science? and second, in what sense is this the age of science?

First, then, what is science? Surely there can be no difficulty in answering this, and yet I fear that, if I should pass through this or any other audience with the question, I should get many different answers.

A certain lady, whom I know better than any other, has told me that, should she ever be permitted to marry a second time, she would not marry a scientific man, because scientific men are so terribly accurate. I often hear the same general idea expressed, and it is clear that accuracy is one attribute of science according to prevailing opinions. But accuracy alone is not science.

Again, there are those who seem to think that science is something that has been devised by the Evil One for the purpose of undermining religion. This idea is not so common as it was a few years ago, when the professors of scientific subjects in our colleges were generally objects of suspicion.

Probably the idea most commonly held in regard to science is that it is something that gives us a great many useful inventions. The steam engine, the telegraph, the telephone, the trolley car, dye stuffs, medicines, explosives—these are the fruits of science, and without these science is of no avail. I need only say now that useful inventions are not a necessary consequence of scientific work, and that scientific work does not depend upon useful applications for its value.

Science, then, is not simply accuracy, although it would be worthless if it were not accurate; it is not devised for the purpose of undermining religion; and its object is not the making of useful inventions. Then what is it? One dictionary gives this definition: "Knowledge; knowledge of principles and causes; ascertained truth or facts.". . . "Accumulated and established knowledge which has been systematized and formulated with reference to the discovery of general truths or the operation of general laws." . . . "Especially such knowledge when it relates to the physical world, and its phenomena, the nature, constitution and forces of matter, the qualities and functions of living tissues, etc."

One writer says: "the distinction between science and art is that science is a body of principles and deductions to explain the nature of some matter. An art is a body of precepts with practical skill for the completion of some work. A science teaches us to know; an art, to do. In art, truth is a means to an end; in science it is the only end. Hence the practical arts are not to be classed among the sciences." Another writer says: "science and art may be said to be investigations of truth; but one, science, enquires for the sake of knowledge; the other, art, for the sake of production; and hence science is more concerned with the higher truths, art with the lower; and science never is engaged, as art is, in productive application." Science, then, has for its object the accumulation and systematization of knowledge, the discovery of truth.

Second, in what sense is this the age of science? In the first place, it is not true that science is something of recent birth. Scientific work of one kind and another has been in progress for ages—not in all branches to be sure—but nature has always engaged the attention of man, and we may be sure that he has always been trying to learn more about it. The science of astronomy was the first to be developed. Astrology was its forerunner. Then came chemistry in the guise of alchemy.

To make clear the nature of this obstacle, it will be best to make a comparison. A child learns a great deal in regard to his surroundings in his earliest years before he goes to school, and without the aid of his parents. He is constantly engaged in making observations and drawing conclusions, and his actions are largely guided by the knowledge thus gained. After a time school life begins, and the child then begins to study books and to acquire knowledge at second-hand. This is an entirely different process from that by which he gained his first knowledge. The latter is natural, the former is artificial. Then, too, he soon discovers that many things he sees call for explanation, and he is led to wonder what the explanation is. If he has a strong imagination, as most children have, he will probably think out some explanation. He finds that he can use his mind, and that this helps him in dealing with the facts in nature. Now comes the danger. It being much easier to think than to work, the chances are that in trying to find the explanation of things, he will give up the natural method and be satisfied with the products of his imagination. He will gradually give up dealing directly with things, and take to thinking alone. When this stage is reached his knowledge will increase very slowly, if at all.

Whether this picture of the development of a child is in accordance with the facts of life or not, it gives an idea of the mental development of mankind. First came the period of infancy, during which observations were made and much learned. Efforts were early made to explain the facts of nature. We have remnants of these explanations in old theories that have long ceased to be useful. They no doubt served a useful purpose in their day, but gradually one of the most pernicious ideas ever held by man took shape, and I am willing to characterize it as one of the most serious obstacles to the advance of knowledge. I refer to the idea that it is a sign of inferiority to work with the hands. This idea came early and stayed late. In fact, there are still on the earth a few who hold it. How did this prove an obstacle to the advance of knowledge? By preventing those who were best equipped from advancing knowledge. The learned men of the earth for a long period were thinkers, philosophers. They were not workers in nature's workshop. They tried to solve the great problems of nature by thinking about them. They did not experiment. That is to say, they did not go directly to nature and put questions to her. They speculated. They elaborated theories. During this period knowledge was not advanced rapidly. It could not be. For the only way along which advances could be made was closed.

Slowly the lesson was learned that the only way by which we can gain knowledge of nature's secrets is by taking her into our confidence, as it were. Instead of contemplation in a study, we must have contact with the things of nature either out of doors or in the laboratory. Manual labor is necessary. Without it we may as well give up hope of acquiring knowledge of the truth. When this important fact was forced upon the attention of men,

[1] Commencement address delivered at the Worcester Polytechnic Institute, June 9, 1904—Abridged.

scientific progress began and continued with increasing rapidity. At present the old pernicious idea that a man who does any kind of work with his hands is by virtue of that fact an inferior being—that idea is no longer generally held. It has been disappearing rapidly for some years past, and with its disappearance the development of science has kept pace. Which is the cause and which the effect it would perhaps be hard to say. At all events the growth of every department of science has been more rapid within the last fifty years than during the preceding fifty years, though we should be doing gross injustice to our predecessors were we to belittle their work. Many and many a great discovery in science preceded the present age, but from what I have already said, you will see that the reason for calling this age in which we live the scientific age is found in the fact that scientific work is much more extensively carried on at present than at any time in the past; and, further, the world is beginning to reap the rewards of this work. So striking are some of these rewards that they appeal to all. The world is dazzled by them, and is to a large extent unable to distinguish between the scientific work which has made these rewards possible and the rewards themselves. The idea is prevalent that scientific work is carried on in order that rewards in the shape of practical results may be reached. I have no desire to bring my fellow workers in science into disrepute, but I will try to make it clear to you that one may be engaged in scientific work all his life, never thinking of what the world calls practical results, that he may in fact not achieve a single result that can be called practical, and yet not waste his time; and that one may hold such a worker up to admiration without running much risk of being taken for a fool.

During the latter half of the last century there lived in Sweden a poor apothecary who, in his short life, probably did more to enlarge our knowledge of chemistry than any other man. Throughout his life he had to contend with sickness and poverty. He was obliged to carry on the business of an apothecary in order to keep the wolf from entering his house—he never succeeded in keeping it from the door. His great delight was to investigate things chemically, and to find out all he could about them. It is simply astounding to the chemist to find how many discoveries of the highest importance he made. But I have not mentioned his name. I refer to the immortal Scheele. He died in the year 1786 at the age of forty-three, yet he will always be remembered, and those who know most of the work he did will respect him most.

Though Scheele was an apothecary, his chemical work was not practical in the ordinary sense, and it was no doubt often difficult for him to explain what he was doing. His most important discovery was that of oxygen—a discovery that was made at the same time (1774) by the English clergyman, Priestley. Chemists know that this is one of the most important discoveries ever made in the field of chemistry, and, filled with this conviction, in 1874, one hundred years after the discovery was made, the chemists of the United States made a pilgrimage to Northumberland on the Susquehanna to do honor to the memory of Priestley, who there spent the last years of his life.

But why was this discovery so important? Oxygen, to be sure, is the most widely distributed and the most abundant substance in and on the earth; it plays a controlling part in the breathing of animals, and in most of the changes that are taking place upon the earth; a knowledge of it and of the ways in which it acts has done more than anything else to give chemists an insight into chemical action in general; and therefore has contributed more than anything else to the development of chemistry. All this is no doubt true, but are these results practical? Could we go out into the world and form a company and sell stock on the basis of such a discovery? Or could the discoverer in any way realize in cash? The average man of the world would say "No! there is nothing in it. It may be well for a few men who have not the power to compete with their fellow men in the busy marts to devote themselves to such useless pursuits. Possibly something may come of it in time, but better something practical, something that can be converted into hard cash. That is the test, and the only fair test by which we can judge whether any particular piece of scientific work is or is not of value."

But I have already said that the discovery of oxygen was the most important discovery ever made in chemistry, and I might have added, the most valuable. In what then did its value consist? In the fact that it led to a more intelligent working with all things chemical. Operations that had before this discovery appeared mysterious suddenly became clear, and everyone engaged in chemical work was helped in many ways. If it is not enough for us simply to gain a clearer insight into the processes around us, if we must insist upon more tangible reward, no doubt it could be shown that the discovery of oxygen has contributed largely to the material welfare of mankind—not directly perhaps, but by enlarging our knowledge of chemistry, so that it may be said that most discoveries made since 1774 have been in a way consequences of the discovery of oxygen. Indirect results are often of more value than direct ones.

This is the lesson that we learn over and over again as we study the great industries. Rarely have they been the results of work undertaken with the object of attaining the practical. Look at the beginnings of electricity. A piece of amber when rubbed attracts bits of pith. A frog's leg twitches after death when touched in certain ways with metals. That was all. Are such things worth investigating? No doubt the practical man said: "no; stop trifling: do something worth doing." And if he had been permitted to have his way, all the wonderful results that depend upon the applications of electricity would have been impossible. In every line, much study, much work, and much investigation are absolutely necessary before enough knowledge can be got together to make profitable, practical applications possible. During this early preparatory stage the work is of no direct interest to the purely practical man; and yet without this work the applications which he values would be impossible. Scientific work in its highest form does not pay directly. Those who devote themselves to the pursuits of pure science do not, as a rule, reap pecuniary reward. They probably enjoy their lives as much as if they did, though it is often difficult to make them believe this. But because it does not yield immediate reward to the worker, should the work stop? Surely not. Our only hope of progress in intellectual as well as practical matters lies in a continuation of this work. And even though not a single tangible, practical result should be reached, the work would be valuable. Why? Because we are all helped by knowledge. The more we know of the universe the better fitted we are to fill our places in the world. All will concede that proposition. But if that is true we have the strongest argument for scientific work, for it is only through such work that we are enlarging our knowledge. There is no other way of learning. Somebody must be adding to our stock of knowledge, or what we call progress in intellectual and material things would stop. It also seems probable that moral progress is aided by intellectual progress, though it might be difficult to make this perfectly clear. I believe it is so; though of course it does not follow that every individual furnishes evidence of the relation between intellectual and moral progress.

METHODS OF LOADING MACHINES FOR TESTING PURPOSES — SUPPLYING ONLY THE LOSSES—II.

BY E. A. REGESTEIN.

TRANSFORMERS.

The method pursued in loading transformers is necessarily quite different from the methods described above for direct-current machines.

In Fig. 7 are shown two transformers, the low-tension sides of which are connected in parallel to a supply circuit having the rated voltage and frequency of the transformers through the switch A. The relative directions of the impressed electromotive force on the low-tension coils and of the induced electromotive force in the high-tension coils are indicated by the arrows. If the high-tension coils are connected in series, as shown, the voltages induced in the two coils will neutralize each other; and, therefore, with switch B open, the voltmeter V_2 will read zero. If, now, an auxiliary electromotive force be introduced by closing the switch B, this electromotive force will cause current to flow through each of the two high-tension coils, independent of the voltage induced in these coils from the circuit at A.

Now let us assume, for the time being, switch A to be open. Since each of the two transformers is short-circuited through the low-tension coil of the other, with respect to electromotive force applied at B, the two transformers will behave practically as short-circuited transformers. The current, then, flowing in the high-tension coils, and, therefore, likewise that in the low-tension coils, will depend directly on the voltage applied at B and inversely on the impedance of the two transformers in series. Hence to make full-load current circulate in the transformers, it is necessary to apply at B a voltage equal to twice the impedance voltage of a single transformer. If switch A is now closed, the two transformers will each be excited to their normal voltage. Since the electromotive forces induced in the high-tension coils oppose one another, opening or closing the switch A will have no effect on the current flowing in the high-tension coils, and will merely cause the addition of the magnetizing current to the low-tension coils.

The reason for supplying the magnetizing current on the low-tension side and the load current on the high-tension side is merely one of convenience. Since the impedance drop is usually only a few per cent of the rated voltage of the transformer, a very low voltage would be required if it were to be supplied to the low-tension coils of a transformer having a ratio of transformation of 2,200/1,100/-110. If we assume four per cent as the impedance drop, then with the transformers connected up for 1,100 volts and supplying the impedance losses on the high-tension side, we shall require about eighty-eight volts at B, to force full-load current

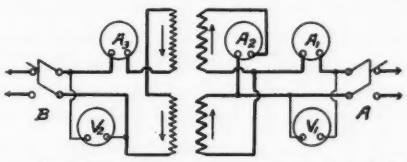


FIG. 7.—TWO TRANSFORMERS, WITH LOW-TENSION SIDE CONNECTED IN PARALLEL WITH SUPPLY CURRENT.

through the two transformers in series. The core losses, being supplied on the low-tension side, will require a 110-volt circuit. Thus we handle only safe and convenient voltages.

With the connections shown in Fig. 7, the core losses and magnetizing current are supplied at A, and the full-load current and copper losses are supplied at B. Since the transformers are each excited to normal voltage and have normal full-load current flowing in their respective coils, they are under full-load conditions, although the losses only are supplied. Wattmeters inserted at A and B will measure the core and copper losses of the two transformers directly. If W_1 and W_2 be the readings of these two wattmeters, respectively, then $\frac{W_1 + W_2}{2}$ = the total losses occurring in one of the transformers. If the reading of the voltmeter V_1 equals E and that of ammeter A_2 equals I, then the efficiency of one of the transformers may be computed as

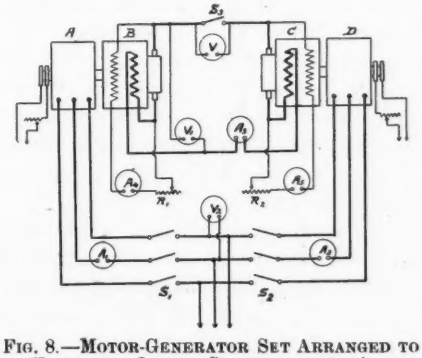


FIG. 8.—MOTOR-GENERATOR SET ARRANGED TO HAVE THE LOSSES SUPPLIED FROM ALTERNATING-CURRENT SIDE.

$$\frac{EI}{EI + \frac{W_1 + W_2}{2}}$$

To obtain the efficiency, however, it is of course not necessary to load the transformers, since the core loss, represented in the above expression by $\frac{W_1}{2}$, may be measured directly at no load on a single transformer, by measuring the power input by wattmeter when connected to mains of rated voltage and frequency; and the copper losses represented above by $\frac{W_2}{2}$ may be computed from measurements of the resistance of the coils of the transformer.

The auxiliary voltage required at B (Fig. 7) may be derived from the same circuit as supplies A, or may be derived from an independent machine having the same frequency. In either case the voltage must be capable of adjustment, in order gradually to bring the current up to the desired value.

SYNCHRONOUS MOTOR DIRECT-CURRENT GENERATOR SETS.

Two similar motor-generator sets may be loaded very conveniently by the same general method described above for direct-current machines, the output of the motor, however, being transmitted back to the generator through the alternating-current machines, instead of through the belt. The losses may be supplied on either the direct-current or the alternating-current side. Fig. 8 represents such a set arranged to have the losses supplied from the alternating-current side. A and D represent the two synchronous motors, direct-connected to the two railway generators B and C.

The motors, being polyphase machines, may be started by connecting their armatures to the supply circuit at one-half voltage, derived either through starting compensators or by reducing the supply voltage, if it is under control. The field circuits must be open at starting, if the motors are started in this way. After they have come up to speed, the field circuits are closed, the voltage brought up to normal value, and the field currents adjusted until the ammeters A_1 and A_2 read a minimum, in which case we have the motors running at unity power-factor. If no starting compensators can be rigged up, and the voltage of the supply circuit can not be reduced, we have two other methods of starting. The first one is to shut down the alternator and bring all the machines up to speed together. With the alternator standing still, and having normal field excitation, close the switches S_1 and S_2. Now on starting the alternator slowly, A and D will come up in synchronism with it. A and D will start most readily with no field excitation. As soon as they have started to turn, their

field excitation may be adjusted to normal value. The second method is to start the machines from the direct-current side by connecting B and C to a suitable circuit, and then synchronizing both A and D with the alternating-current supply circuit across S_1 and S_2, respectively. The direct-current source is then discontinued. B and C are now built up to their normal voltage, in such a way as to oppose each other. When the voltmeter V across switch S_3 reads zero, the switch may be closed and no current will flow. If, now, the field of B is weakened, current will flow into B's armature from C, causing it to act as a motor. Weakening its field will also tend to make B speed up, and, as A is direct connected to B, it will also tend to speed up A. Since, however, A is running in synchronism with the supply mains, its frequency can not be raised above that of the mains. This tendency will cause A to act as a generator, sending power to D, and thus absorbing the power that B, running as a direct-current motor, receives from C and gives out at its shaft. Machine D, running as a synchronous motor receiving its power from A, has its power absorbed in driving C, thus returning to C's shaft the power that it is sending out from its brushes to B, minus the losses in the system, which are supplied by the mains. With the losses supplied on the alternating-current side, in this manner, the speed is controlled by the frequency of the supply circuit. Assuming B to be the motor, the voltage of the direct-current machines is controlled by R_2, the field rheostat of the generator C, while the load on the entire system is controlled by R_1, the field rheostat of the motor B. Weakening B's field increases the load, and *vice versa*. If B's field were strengthened sufficiently the load would be reduced to zero, and then B would become the generator.

Fig. 9 shows connections for supplying the losses on the direct-current end. The system as shown can be started as follows: by connecting a suitable starting rheostat across S_1 and S_2, respectively, B and C may be started from the supply mains, and their speeds then brought to normal by their respective field rheostats. Machines A and D are now brought up to their normal voltage and synchronized across S_3, the speed being adjusted by the field rheostat R_1 or R_2. The system may also be started by first exciting both A and D to their normal field currents. Then, with switch S_3 closed, start machine B and with it A. D will also start and run in synchronism with A. Now equalize the voltages across S_2 by the field rheostat of C, and when V reads zero close S_2.

With the system connected up as in Fig. 9, taking the loss supply from the direct-current end, if the field of B be weakened, B will act as a motor as before and will likewise speed up, carrying A with it and therefore D and C which run in synchronism with A. The speed of the system, therefore, is now controlled by R_1, the field rheostat of the motor B. Since, however, the speed must be kept constant at the rated value of the machines, we can not control the load on the system by R_1 as was the case when supplying the losses from the alternating-current end. The load is now controlled by R_2, the field rheostat of the generator C. Increasing the field strength of C increases the amount of power circulating in the system. The voltage of the direct-current machines is determined by the voltage of the loss supply circuit. This voltage may

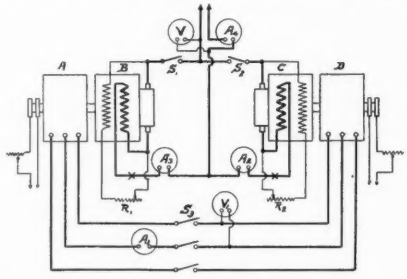


FIG. 9.—MOTOR-GENERATOR SET ARRANGED TO HAVE LOSSES SUPPLIED FROM DIRECT-CURRENT SIDE.

be kept at the proper value by means of a separately excited booster, as previously described under rotary converters. The field current of generator A is adjusted to give the rated difference of potential at its terminals. The field current of motor D is adjusted so that the current flowing in the mains, as indicated by A_1, is a minimum for given load, indicated by A_2 on the direct-current machines, in other words, so that D is running at unity power-factor.

If tests are to be made on the voltage regulation of the direct-current machines, or they are to have shunts adjusted across their series fields, to give the proper degree of compounding, it is necessary to supply the losses from the alternating-current side. If the loss supply were on the direct-current side, the loss supply voltage would determine the voltage of the machines.

It is to be noticed that in the case of the loss supply on the alternating-current side, machine D, which, it has been assumed, is acting as the motor, is carrying a somewhat greater load than A, while B and C each has the same current, except for the slightly greater current carried by the generator C due to the fields of B and C. With a direct-current loss supply, on the other hand, machine B, which is acting as the motor, carries a current equal to that delivered by C plus the loss supply current, while A and D both carry the same current.

INDUCTION MOTOR—DIRECT-CURRENT GENERATOR SETS.

Induction motor sets may be started and loaded in the same manner as is pursued in the case of synchronous motor sets. The actions taking place on the alternating-current side are, however, somewhat different in the present than in the former case.

If, in Fig. 8, we omit the collector rings shown for the revolving fields of machines A and D and their respective field rheostats, the diagram will suffice for the present case also. With induction motors, however, we can not take the loss supply from the direct-current side, as was possible with synchronous motors, but must take it from the alternating-current side, in order to supply the magnetizing current to the machine which is to act as the induction generator.

If the induction motors are of the type having armature starting resistance, the motors may be started directly from the mains at full voltage. If their armatures are of the squirrel-cage type, they should be started by one of the methods given under synchronous motor sets, to bring them up to speed before connecting them to the mains at full voltage, in order to avoid excessive starting current.

The system having been started, the direct-current machines equalized and thrown together, then, if the field of B is weakened, its armature will take current from C, causing B to run as a motor. Weakening B's field will likewise cause it to speed up, carrying with it its direct-connected machine A. As soon as the speed of A is brought above synchronism it acts as an induction generator, as is well known—the higher its speed above synchronism the greater its output. The output of A is absorbed by D, running as a motor to drive the generator C. As with synchronous motor sets, the volts on the direct-current machines are controlled by the field rheostat of the generator B, while the load on the entire system is controlled by the field rheostat of the motor B. It will be seen that the two sets no longer run at the same speed. The frequency of the supply mains should be the normal frequency of the induction motors. At full load the speed of the set

CD will be below synchronous speed by the amount of slip of the motor, while the AB will be running above synchronism. As the system is loaded the amount of power from the supply circuit only increases as the total losses in the system.

The foregoing cases might be considered as standard methods. They can always be used when the necessary machines are at hand. It frequently happens, however, that it is necessary to test a large machine at full load when there is no duplicate at hand with which to test it. Nevertheless, there may be suitable machines available for use, which may be combined into a system to circulate the power. The method to be pursued would, of course, depend on circumstances. A few of such cases, with which the writer has had to deal, may be of interest.

A 500-kilowatt, 525/575-volt, direct-current, slow-speed railway generator was to be tested. This machine, represented by A in Fig. 10, was assembled for test in a testing stand so arranged that the armature shaft could be directly coupled, by means of the flange coupling G, to the shaft of the engine B, running at 100 revolutions per minute. This engine was especially equipped as a source of power for the testing department. It could be direct-connected to slow-speed generators assembled in the testing stand, and was also provided with a very large pulley F, from which to drive belted machines. The governor of this engine was so arranged that the speed could be varied over a considerable range in the vicinity of 100 revolutions per minute, and the speed of the engine could be kept constant for changes in load.

It so happened that a 500-kilowatt motor-generator set consisting of a 525/575-volt railway generator direct connected to a 2,300-volt, three-phase, synchronous motor was ready for test at the same time. This set was made use of. It is represented by CD, Fig. 10. E represents a 500-kilowatt, three-phase, 2,300-volt generator used as a shop machine to give power for testing purposes. It was belted to the large pulley F on the engine shaft.

The scheme of the circulation of the power output of our machine was as follows: A, the machine to be tested, was run as a generator, being driven by the engine shaft and its output transmitted by the electrical connections to the machine C, which ran as a direct-current motor. C's output was transmitted by its shaft to D, which was run as an alternating-current generator. E, running as a synchronous motor, absorbed the output of D. Finally the output of E was transmitted by the belt back to the engine shaft. Thus the engine was required to supply only the losses occurring in the system.

The procedure in starting the system is as follows: On starting the engine, machines A and E were brought up to speed.

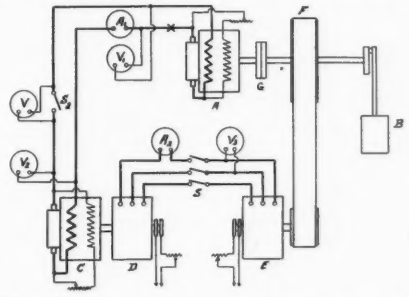


FIG. 10.—DIRECT-CURRENT GENERATOR ARRANGED FOR DIRECT COUPLING TO ENGINE.

Now with the switches S_1—connecting D and E_1—closed and with the field circuit of D open, the voltage of E is gradually built up until D starts and comes up to synchronous speed. The field circuit of D is now closed and the field excited. The voltage of E is now built up to 2,300 volts, the normal voltage of both D and E, and the field current of D increased to normal value, determined by the minimum reading of the ammeter A_2. The voltages of A and C are now each built up to their normal value. When voltage

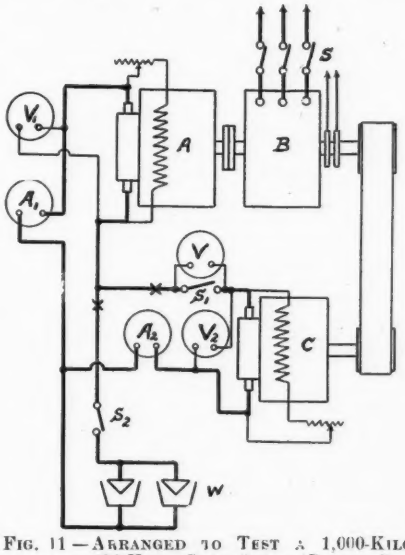


FIG. 11.—ARRANGED TO TEST A 1,000-KILOWATT, 250-VOLT, SLOW-SPEED, DIRECT-CURRENT GENERATOR AT FULL LOAD.

across switch S_2 is zero, S_2 is closed. Now the field of C is weakened. C can not speed up since D runs in synchronism with E and hence its speed is governed by that of the engine. Weakening C's field, however, allows current to flow into its armature from A. This current will exert sufficient torque to cause an angular advance, or a shifting of the phase relation of D's armature with respect to that of E, thereby causing D to send power into E. This power, minus that used up in overcoming the losses, is transmitted by the belt from the pulley of E back to the engine shaft. The engine shaft, in turn, drives the generator A. It will be seen, therefore, that of the output of A, part is consumed in overcoming the losses in the three machines, while the rest is restored to the engine shaft. Thus it will be seen that the engine supplies an amount of power equal only to the losses occurring in the system.

The speed is kept constant at the engine governor, at the rated speed of the generator A, which is being tested. The voltage of A is controlled by its field rheostat. The load on A is controlled by the field rheostat of the machine C, which runs as a motor. The voltage between the alternating-current lines is kept constant at rated value by the field of D. The field of E is adjusted so that E runs at unity power-factor.

For tests at full load the above arrangement sufficed. The generator A, however, was also to be tested at an overload which was greater than machine C would safely stand, it not being designed for as severe overload requirements as were demanded of A. The additional load was obtained by connecting water rheostats in multiple with C. Another direct-current machine might, however, have been belted to the pulley F from the opposite side from E (the pulley being large enough to accommodate a belt in each direction), and connected to A in parallel with C. The machine would be connected to A by the same procedure as was followed in the case of C and then weakening its field will cause it also to act as a motor, restoring its power directly to the shaft.

The connections shown in Fig. 10 were also used for testing the motor-generator set CD. In this case, however, the power was made to circulate in the opposite direction. With the system started in the same manner as previously described, if A's field be weakened, A will act as the motor, and C as the generator. The output of A is then transmitted by the belt to E, running E as a generator. E's output is consumed in running D as a synchronous motor. D, in turn, drives C as a direct-current generator supplying the motor A. The engine, as before, supplies the losses in the system.

In this case the engine speed was adjusted to run E at such speed as to give the rated frequency to the synchronous motor D. Direct-current volts are now

controlled by the field of C, while the field of A controls the load.

Fig. 11 represents the arrangement used to test a 1,000-kilowatt, 250-volt, slow-speed, direct-current generator at full load. A is the machine to be tested. To drive A, a 1,500-kilowatt, three-phase alternator, shown as B, which happened to be available and whose rated speed was about the same as that of A, was connected to the generator to be tested by a flange coupling, the two machines both being assembled in temporary bearing blocks. To the outer end of B's shaft was attached a pulley to which was belted the 500-kilowatt, 250-volt, direct-current machine C. Facilities were not at hand by means of which all the power output of A could be pumped back. The machine C could take one-half of the output of A which it returned to the shaft by its belt, C running as a motor. Full load was taken from A by loading it on the water rheostat W connected in parallel with C. Machine B was run as a synchronous motor, being fed by mains coming from an engine-driven alternator, the speed of the engine being adjusted so that A was run at normal speed.

To start the system C was first started from an external 250-volt source, thereby turning machines A and B over. B was then synchronized with the alternating-current mains across the switch S, and, synchronism having been attained, the switches S were closed. C was now disconnected from the external 250-volt source.

The voltages of A and C were now each built up to normal value and equalized, switch S_1 being closed when voltmeter V read zero. The field of C was then weakened until C took as much current as it would safely carry. This current was indicated by the ammeter A_2. C, running as a motor, restored its power back to the shaft by means of the belt. The total load on A, as indicated by ammeter A_1, was then brought up to normal by adjusting the water rheostats W.

A in Fig. 12 represents an induction motor that was to be tested. In this instance the source of power was an engine-driven double generator B. To load A it was belted to the direct-current generator C. The output of C was pumped back on the direct-current end of the double-current generator B.

The principal involved in this arrangement is, in general, the same as in previous problems. Motor A is started from B. A and C being belted together, C starts with A. The generator C is now built up to normal voltage and its voltage equalized with that on the commutator end of the double-current generator, across the switch S_1 and the switch closed. Now, increasing the field strength of C causes it to act as a generator, sending current into B. C being loaded as a generator requires more power to drive it. The first tendency is to slow

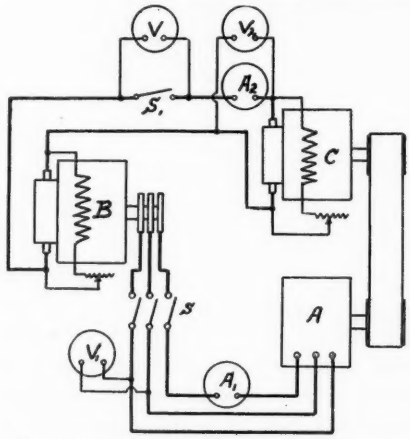


FIG. 12.—INDUCTION MOTOR WITH ENGINE DRIVE.

down the motor A. From the characteristics of an induction motor it will be readily seen that at lower speed the motor has greater torque and absorbs more power.

Hence, as the voltage of C is increased, power flows from it to B, and the input from A increases proportionally. The load on the motor A is therefore controlled by the field rheostat of C. The volts at the motor terminals are controlled, of course, by the field rheostat of the generator B.

Fig. 13 shows the connections used in

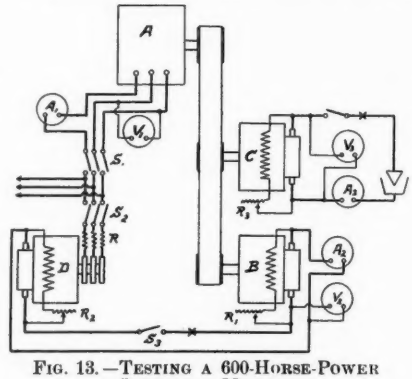


FIG. 13.—TESTING A 600-HORSE-POWER INDUCTION MOTOR.

testing a 600-horse-power induction motor in a particular instance. In this case, with the machines at hand, it was not possible to pump the entire load given out by the motor back on the supply mains. The figure indicates the induction motor A, belted to the two direct-current generators B and C, each having 300-kilowatt capacity. The machine B is in electrical connection with the 300-kilowatt rotary converter D. D is connected back to the alternating-current mains supplying the motor A, through the induction regulator R and the switches S_2. In this way we have established a complete circuit for returning to the mains as much of the power output of A as can be carried by B and D. Since the capacity of B was only 300 kilowatts, it could not carry sufficient load to load A to its normal capacity. The difference between the capacity of A and that of B was made up by belting a second direct-current generator C to the motor. C was loaded on water rheostats until the combined load on B and C required full-load output from A. Full load on the motor was determined by the reading of the ammeter A_1—the current taken by the motor at full-load output having been previously determined.

The following order of procedure is carried out in loading the motor. A is started from the alternating mains; A will now be turning B and C over. B having been built up to its normal voltage, D is started from B, a suitable starting rheostat being temporarily connected across S_3. The voltage on the collector side of the rotary converter D is boosted by the induction regulator R to equal that of the alternating mains. D is now synchronized with the supply mains across the switches S_2, its speed being regulated by its field rheostat R_2. D can now be made to take load by decreasing its field strength by means of its field rheostat, thus giving B a tendency to speed up. Since D runs in synchronism with the alternating mains, this tendency will not actually increase its speed, but will cause it to deliver power on the alternating side, running as an inverted rotary. The same result may be obtained by increasing the voltage of B by regulating R_1. To have this second method most effective, the field coil of the rotary should be separately excited, in order that the increased impressed voltage may not be accompanied by an increase in field current, thus neutralizing, to a certain extent, the tendency of the machine to speed up. In this way D is loaded up until the capacity of B and D is reached. Then C is loaded on water rheostats until ammeter A_3 indicates that the motor A is fully loaded.

The above examples indicate the methods employed in work of this kind. The actual combination of machines will depend on circumstances. Where many machines come through to be tested there are generally some machines available with which to load a given machine. Sometimes all of the power can be circulated, and sometimes a part only of the power can be pumped back, the rest being consumed in water rheostats.

EDUCATIONAL EXHIBITS IN THE PALACE OF ELECTRICITY.

THE MANUFACTURE OF INCANDESCENT LAMPS AT THE WORLD'S FAIR, ST. LOUIS.

[*By Our Special Correspondent.*]

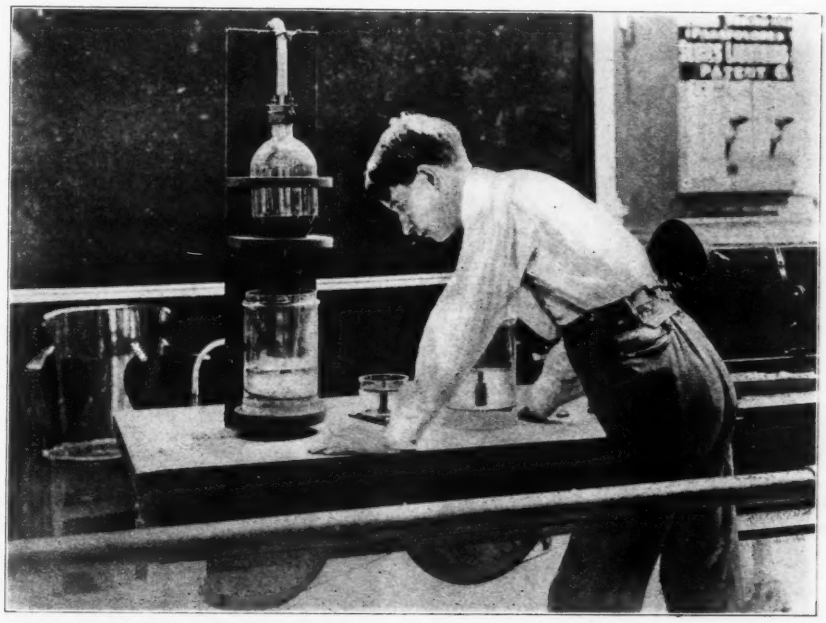
The Louisiana Purchase Exposition, in its early pamphlets and other literature, soliciting exhibits from the world at large, urged that these be made working wherever possible, and of such character as to be of the greatest value from an educational standpoint. So many of the displays to be seen in any of the exhibit palaces have been planned and installed with this idea uppermost, that the whole may aptly be termed a "working exposition." Particularly in the Palace of Electricity do the exhibits stand as public educators, as, from the first, it has been the aim of Chief Goldsborough to bring together a collection of working and semi-working exhibits that would enable the public to comprehend more readily the principles and operation of the more common electric mechanisms, as well as form a school-room for the student in engineering, and an unparalleled opportunity for world-wide advertising by the exhibitor.

It is strangely true that, of the thousands of visitors who enter the Palace of Electricity each day, but few have any idea of the way in which an electric car is propelled, although they use this means of transit daily, nor have they any conception of the working of a telephone exchange, although they constantly make use of this time-saver. But this does not mean that the public is averse to knowledge, as the crowds that constantly line these working exhibits testify. For instance, an average of 6,000 persons daily enter the space of the American Telephone and Telegraph Company, where is installed the exposition exchange of the Bell Telephone Company. Attached to this exhibit are several courteous attendants, who make it a point to explain, in non-technical language, the operation of the board, the capacity of the operators to handle calls, and the main causes of trouble, and surely, one who has listened with any degree of care, to such a talk, is better able to cooperate with the telephone company in securing highly efficient service. The radiaphone, installed jointly by this company and the General Electric Company, also attracts a great deal of attention, over 300 entering the receiving booth a day. An expert army bugler has been secured, and, enclosed in a sound-proof booth under the gallery in the north end of the building, sounds the various calls, these being faithfully transmitted over the beam of a searchlight to the receiving station in the southern portion of the building.

The exhibit which probably attracts more attention than any in the building, and vies with the shoe factory in the Manufactures Building, and the English thread factory in the Palace of Varied Industries, is the model incandescent lamp factory, located in the southwest section of the building. This installation, representing the United States Incandescent Lamp Company, of St. Louis, requires the services of over a score of operators, and has a daily capacity of 1,500 standard sixteen-candle-power, 110-volt lamps. The exhibit is of the greater value because of the fact that, up to the present time, lamp manufacturers have jealously guarded many of the processes connected with their trade, and it is almost impossible for the average person to gain access to any of the large factories. Strange as it may seem, this ignorance regarding the details of lamp manufacture is prevalent among the lamp salesmen, especially in regard to the treatment of the filament, and production of the proper vacuum.

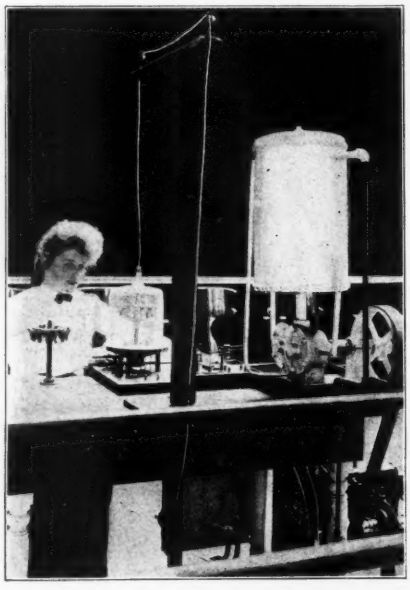
The arrangement of the exhibit is such that, passing around the rectangular enclosure, one sees, consecutively, the different operations and inspections, which are carried on in exactly the same manner as in the factory. The same shop cards are also used to record the output of the various operators, nearly all the employés being paid by the piece.

The vital part of the lamp, upon which its life and efficiency depend, is the filament, and upon its preparation and treatment the greatest care is bestowed. The researches of Edison, in which almost every conceivable substance was tried, resulted in the adoption of the cellulose filament, as the most satisfactory in every respect. Ordinary absorbent cotton is treated with chloride of zinc, the two forming a substance of the consistency of molasses, and of a pale yellow color. The application of heat in a vacuum frees the cellulose from all gases that may have been formed, and still further solidifies it. The cellulose is then placed under air pressure, and forced through a glass die, forming a thread that resembles catgut. A vessel of alcohol receives the filament, revolving at the same peripheral speed as the cellulose is squirted, thereby preventing the straining of the same. The action of the alcohol hardens the cellulose, and permits of its being handled without fear of breaking. The filament is then wound upon a large drum, and allowed to dry, shrinking about fifteen per cent in size. When dry, the filament is cut into suitable lengths—from eight to ten inches, and wound on cardboard or carbon forms of the correct shape. These forms are then placed in crucibles, packed with graphite, and placed in a gas furnace, which is slowly brought to a temperature of 4,000 degrees Fahrenheit. After this carbonization, which further reduces the diameter of the filament about one-half, the carbons, as they are now called, are ready for the final treat-



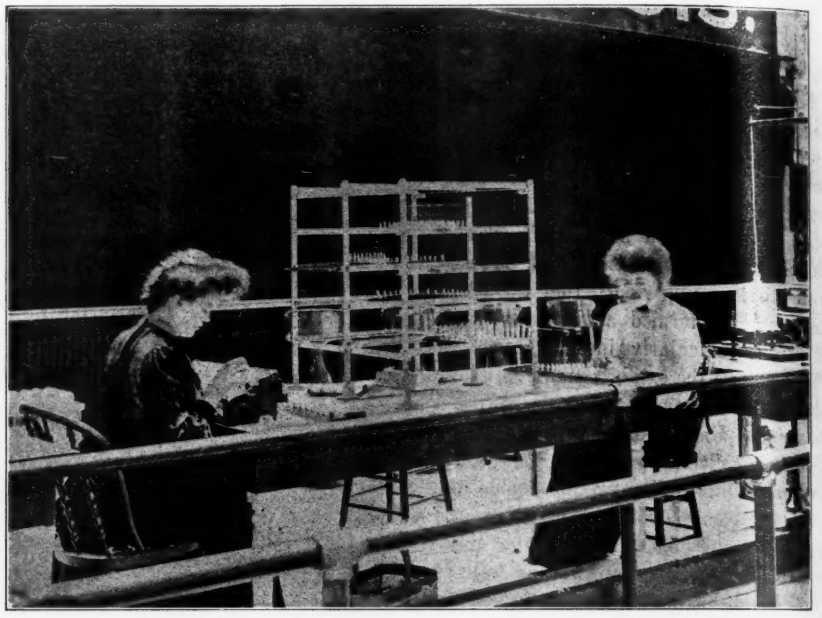
SQUIRTING CELLULOSE FILAMENT; THE MANUFACTURE OF INCANDESCENT LAMPS AT THE WORLD'S FAIR.

ment, called "flashing." They are, at this stage, of various resistances and cross-sections, and minute dents, caused by excessive pressure of grains of carbon in the carbonization process, are not uncommon. It remains, then, to bring them to a uniform and standard resistance, which depends, of course, upon the efficiency and voltage for which the lamps are desired. That is, a high-efficiency lamp will require carbon of higher resistance and consequently smaller diameter than will the lamp designed to burn on a lower wattage per candle. At the same time, the filament being smaller, the life of the lamp is correspondingly reduced. To accomplish these results, the filaments are attached at their extremities to clamps that are connected to a source of current, at a pressure of about 300 volts. Twelve



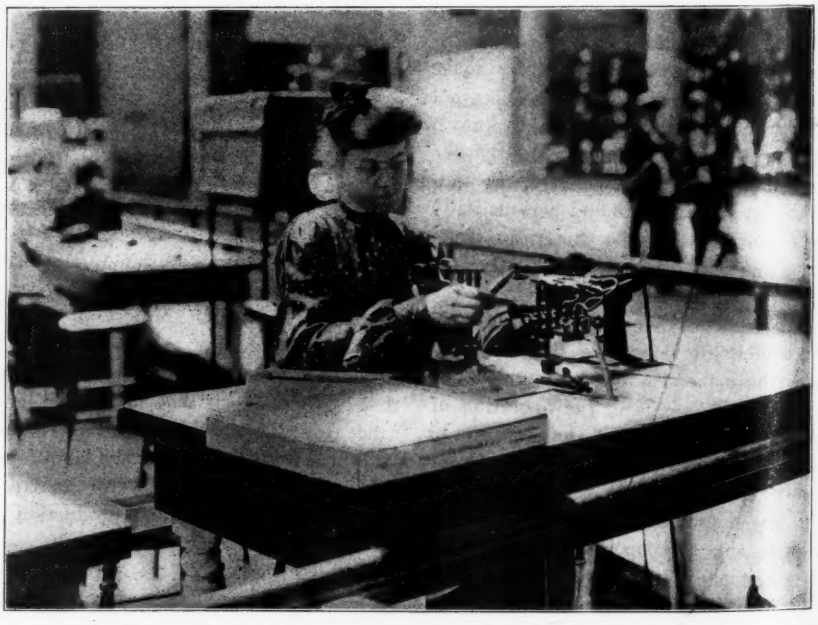
FLASHING FILAMENTS; THE MANUFACTURE OF INCANDESCENT LAMPS AT THE WORLD'S FAIR.

of these clamps are arranged on the circumference of a disc, six inches in diameter, the filament hanging therefrom. The carbons being in position, a glass bell jar is lowered over the whole, and the air is removed by means of a simple form of valveless air pump. A hydro-carbon gas is then admitted, and a switch is closed, allowing current to flow through one of the filaments. The excessive pressure applied to its terminals causes the carbon to immediately become highly incandescent and the intense heat generated decomposes the gas, graphite carbon being deposited in a thin, uniform layer on the carbon. In case the diameter of the filament is less at any point than the normal diameter, this portion, due to its increased resistance, immediately rises to a higher temperature, and consequently carbon is deposited at this point more rapidly than over the rest of the filament, this being continued until the carbon is of uniform diameter throughout its entire length.



ATTACHING CARBON TO STEM AND INSPECTING; THE MANUFACTURE OF INCANDESCENT LAMPS AT THE WORLD'S FAIR.

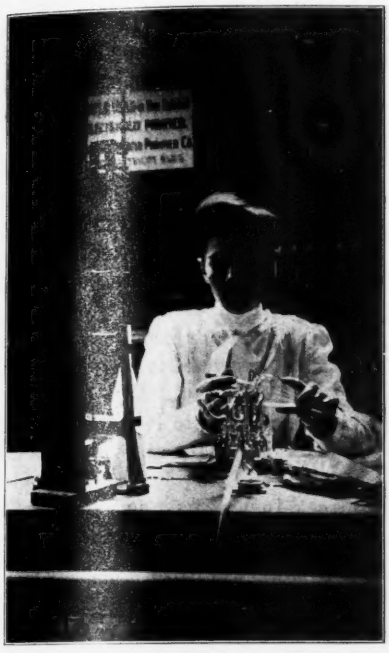
The surface deposit is naturally of much higher density than the core, in fact, its resistance is only about one-tenth of the specific resistance of the core carbon. Thus the total resistance of the filament depends entirely upon the ratios of the amounts of the two kinds of carbon of which it is composed. It is obvious that while the flashing process is going on, the size of the carbon is slowly increasing, with a corresponding diminution of resistance. The current, at the same time, increasing in like proportion, and being a measure of the resistance, it is a simple matter to introduce a small and sensitive circuit-breaker into the leads, this being set to open at a predetermined current that is proportional to the resistance desired for the carbon, the voltage, of course, being maintained uniform. In this way the filaments are made of uniform resistance, and are now ready to be attached to the platinum "leading-in wires."



FORMING FLANGE ON STEM; THE MANUFACTURE OF INCANDESCENT LAMPS AT THE WORLD'S FAIR.

The next step is the formation of the

stem, through which the conducting wires are carried, and which forms the support for the filament and the means of closing the neck of the bulb. The tubing comes in lengths of about five feet, and is



TUBULATING; THE MANUFACTURE OF INCANDESCENT LAMPS AT THE WORLD'S FAIR.

scratched on the edge of a file and broken into lengths of about two inches. These pieces are then placed in a "flanging machine," a simple arrangement of two chucks, one of which holds the end of the tube over a warming flame, while the other swings it into the intense heat of a glassblower's flame. Here the end is almost instantaneously softened, and the operator, with a single twisting motion of a piece of cone-shaped carbon, spins out the flange. While doing this, she inserts a piece of tubing into the lower chuck, and then swings it up into the flame, the flanged tube being ejected from the second chuck. In the next operation the two short pieces of platinum, called the "leading-in wires," and the single piece of nickel wire that supports the carbon in its middle point, are sealed into the other end of the tube, and this is one of the most delicate of the many operations. Previous to this, the platinum tips have been attached to the copper terminals by a most ingenious adaptation of the electric weld. A machine carrying a spool each of the copper and platinum, feeds the wires from each together until they come in contact. The coils themselves being connected to a source of current, the ends of the wires are immediately brought to the weld point, and a minute but perfect butt weld results. The copper and platinum are now cut to the proper lengths, and the "leading-in wires" are ready to be sealed into the stems. The operator picks up the stem with a pair of pliers, and, inserting the plain end into the flame, softens it, and with a deft movement inserts the two "leading-in wires," and pinches the end of the tube together, at the same time adjusting the platinums and pushing the anchor wires into the end just before the sealing process is completed.

The stems are now ready for the carbons, and are slipped into clips on a board covered with white oilcloth. With this board before her, the operator takes a bit of paste, consisting of sugar and graphite, on the end of a needle, and touches

FORMING STEM; THE MANUFACTURE OF INCANDESCENT LAMPS AT THE WORLD'S FAIR.

the end of a filament. This adheres, and is brought into contact with the end of one of the platinum wires, a few delicate strokes making a uniform and strong joint, having a high conductivity. The second end of the carbon is attached in the same manner, and the middle point slipped into the crook of the anchor wire and held firm with a bit of paste. The stems, with carbons attached, are now taken by the last operator, and the carbons straightened, the joints inspected, and they are then taken baked, to remove the moisture from the joints.

The bulbs are blown from the best lead glass, and those used by the United States company are of the type known as "straight side," and conform almost exactly to the shape of the carbon filament used by this company. As they come to the lamp maker, the bulbs have no tip, and the neck is about three inches long. The first step is to puncture the bulb exactly in the centre of its end, and this is done by placing it in a form, under which is a small jet of gas flame. When the glass is sufficiently soft, a sharp plunger descends and makes a hole of the size desired. The operator then takes a piece of glass tubing about two inches long and one-eighth inch in diameter, and seals this into the end of the bulb, necking the tube, and leaving but a minute hole, through which the air is exhausted from the bulb, after the stem has been sealed in.

The stem is sealed into the bulb in a simple machine, resembling a speed lathe. The bulb is placed in a sort of chuck, and the stem, gripped by a pair of long pliers, is inserted in the bulb, and carefully centered, the pliers being gripped by a thumb screw. The bulb and stem are then slowly revolved, and when at the melting point are brought together and a weld results. The bulb must be taken from the chuck and the stem quickly centered, before the glass hardens, and this is a task requiring the greatest skill. The bulb is now attached to an air pump, and partially exhausted, to remove the moisture formed in the sealing process.

CUTTING OFF NECKS OF BULB; THE MANUFACTURE OF INCANDESCENT LAMPS AT THE WORLD'S FAIR.

It is then "painted," this process consisting of the injection of a small quantity of chemical into the tube. After a thorough baking the lamp is ready to be exhausted, and this is one of the most im-

portant as well as interesting of the many steps. The tube is inserted into a heavy rubber inlet, and the two copper terminals attached to clips, supplied through a rheostat, with alternating current, at about fifty per cent higher voltage than that for which the lamp is designed. The valve leading to the air pump is now opened, and, as the vacuum is produced, current is permitted to flow through the filament, and it is brought to such a state of incandescence that the joints are white hot. Under these conditions the whole lamp glows with a blue haze, and the joints shoot out jets of flame. As soon as the blue haze disappears the tube is heated close to the bulb, and the bulb is quickly closed, the current being cut off from the filament at the same time. The lamp is then put to the "glow test," in which one terminal is connected to the secondary of an induction coil, the glow resulting being an accurate indication of the perfection of exhaustion.

The lamps are then ready for the bases, which are attached with a cement that is absolutely waterproof. After having had the two terminal wires soldered to the base, the lamp is ready for the final inspection, and packing. The entire process is more rapid than the telling, and, although the steps are simple in themselves, over forty different inspections are made, and it is an exceptional lamp that is absolutely perfect in all its details. That is, an expert lamp man can pick up almost any lamp and find a flaw of some sort. P. F.

St. Louis, Mo., July 12.

A New Westchester Lighting Company.

The New York & Westchester Lighting Company, of Port Chester, Westchester County, has been incorporated with a capital of $250,000, to operate in New York city, Yonkers, New Rochelle, Mount Vernon and the towns and villages of Westchester County. The directors are Cortland Betts, of Morristown, N. J.; Frederick N. Gilbert, of Brooklyn, N. Y., and Joseph E. Freeman, of New York city. The company's field includes New York city and the entire county of New York; the cities of Yonkers, New Rochelle and Mount Vernon; the towns of Bedford, Cortland, East Chester, Greenburgh, Harrison, Lewisboro, Mamaroneck, Mount Pleasant, Newcastle, New Rochelle, North Castle, North Salem, Ossining, Pelham, Pound Ridge, Rye, Scarsdale, Somers, White Plains and Yorktown and the villages Ardsley-on-the-Hudson, Mount Kisco, Peekskill, Verplanck, Dobbs Ferry, Irvington-on-Hudson, Hastings, Tarrytown, White Plains, North Tarrytown, Chappaqua, Port Chester, Larchmont, Bronxville, North Pelham, Pelham Manor and Pleasantville, in the county of Westchester.

HIGH-SPEED ELECTRIC RAILWAY EXPERIMENTS ON THE MARIENFELDE-ZOSSEN LINE—II.[1]

BY ALEXANDER SIEMENS.

The second report describes the experiments in great detail, and the following

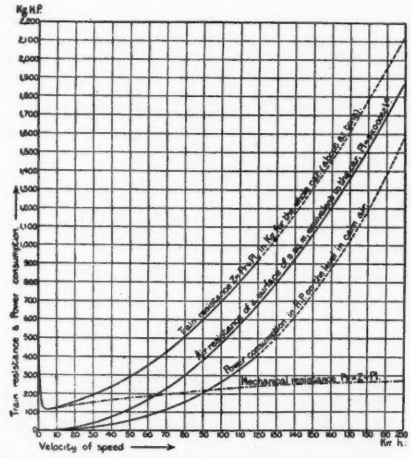
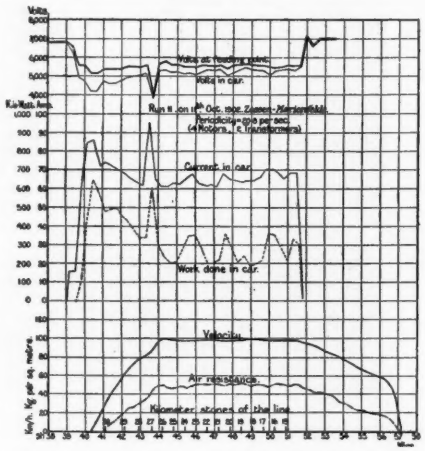


FIG. 7.—FINAL RESULTS OF TRACTION RESISTANCE OF CARS.

are the principal results ascertained by their help: at first attempts were made



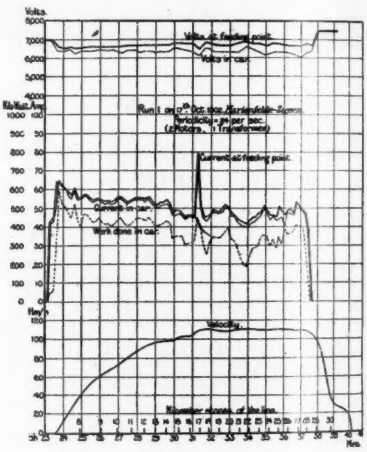


FIG. 8.—RUNS WITH CAR "A," WEIGHT 89,500 KILOGRAMMES—VELOCITY, AIR RESISTANCE, CURRENT, VOLTS, WORK DONE.

to determine the resistance of the cars direct by pulling them at moderate speeds by a locomotive, to which they were attached by a dynamometer. It was found,

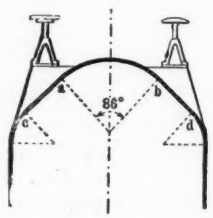


FIG. 9.—FRONT OF THE CAR.

however, that, owing to the great weight of the cars, and owing to the irregular pull of the locomotives, no steady curves

[1] Paper read before the British Institution of Electrical Engineers on May 26—Slightly abridged.

could be obtained, nor was the success greater when the cars were attached to a goods train. Somewhat better results were achieved by the employment of a three-phase locomotive, but the curves were still too irregular to be accepted. Nothing remained but to revert to observing the time each car took to come to a standstill after attaining a certain speed, and the distance it covered during that time, due account being taken of all differences in level. The smallest curve on the line has a radius of 2,000 metres; it was therefore not necessary to consider the curvature in the calculation; but very careful measurements of the air resistance were made by means of tubes projected from the cars in the way already described, and in the end a small correction was found necessary in the formula for air resistance, which was altered to $P = 0.0052\ V^2$, and the resistance of the cars was found to be equal to the resistance of nine square metres. In Fig. 7 the final results of the traction resistance of the cars are represented by four curves showing the total resistance for a car weighing eighty-three tons, the air resistance of the surface of

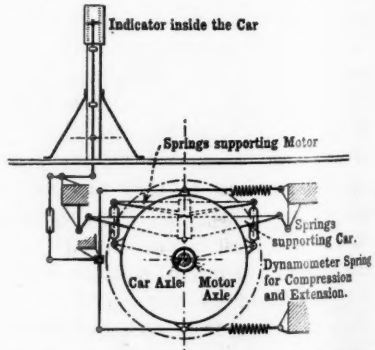


FIG. 10.—SHADED PARTS ARE FIXED POINTS, EITHER ON THE CAR, OR ON THE BOGIE.

nine square metres being the equivalent of the air resistance of a car, the horse-

power required on the level with no wind, and, by the difference of the first and second curves, the resistance due to mechanical friction. It is at once apparent, from this diagram, that at high speeds the air resistance is by far the most important factor, and that the proper shape of the car has to be very carefully determined.

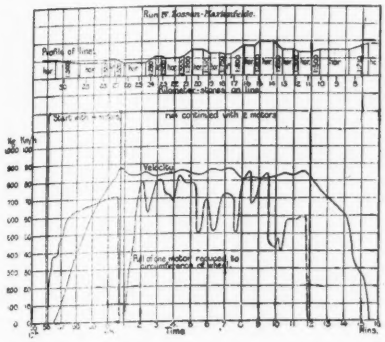
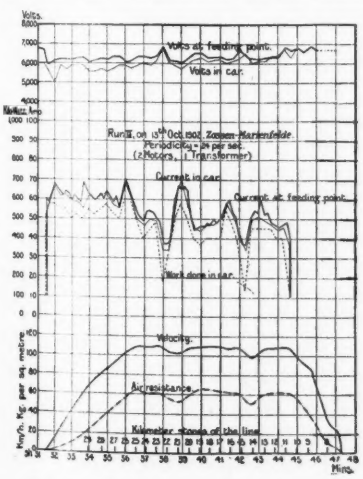


FIG. 11.—TRIAL RUNS OF CAR "A," WITH FOUR-INCH WHEELED TRAILERS—PULL, VELOCITY, AND PROFILE OF LINE.

From their experiments the Studiengesellschaft draw the conclusion that the front of the car should be a rather steep paraboloid. Owing to the necessity of arranging the cabin of the driver in front, and providing buffers and drawbars, it is not possible to carry this out in practice, but the nearest approach to the correct form is suggested to be a cylindrical front, extending for eighty-six degrees, then plain surfaces which join the sides of the car by easy curves, as represented in Fig. 9. Very careful measurements were made as to the amount of energy required, and a measuring station was established at the feeding-point to avoid the calculations of the losses in the feeder. The ammeter and wattmeter at this station were connected direct to the high-tension circuit, to avoid the use of transformers and to make them almost independent of periodicity and of difference in phase. In the cars the instruments were joined to the same phase as at the feeding point. In spite of all precautions, however, the readings were not all reliable, especially in wet weather.



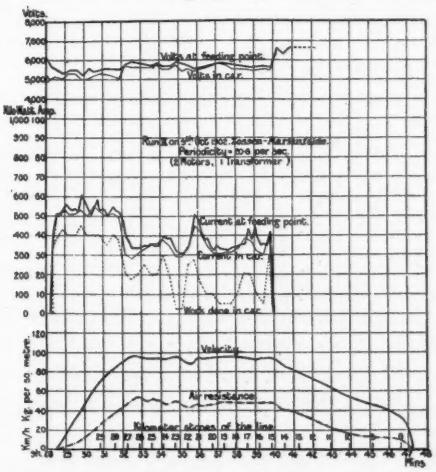
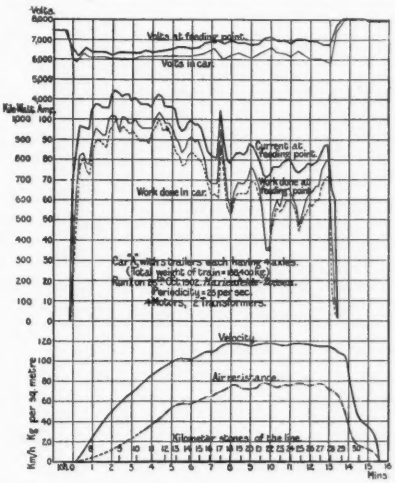


FIG. 12.—RUNS WITH CAR "S," WEIGHT EQUALS 77,900 KILOGRAMMES—VELOCITY, AIR RESISTANCE, CURRENT, VOLTS, AND WORK DONE.

The measurements are divided into two groups: one to determine the energy during acceleration, and the other to measure it at constant speed. In both cases the cars were sometimes running by themselves and sometimes pulling trailing cars. It will be noticed that the acceleration is not very great, but this was the consequence of the generating set not being powerful enough to supply more energy. Compared with the theoretical amount of energy required to give the cars the same acceleration, the figures of the table show an efficiency of about forty-



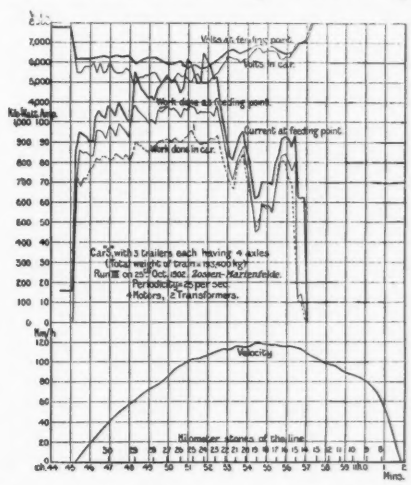


FIG. 13.—RUNS WITH TRAILERS—VELOCITY, AIR RESISTANCE, CURRENT, VOLTS, AND WORK DONE.

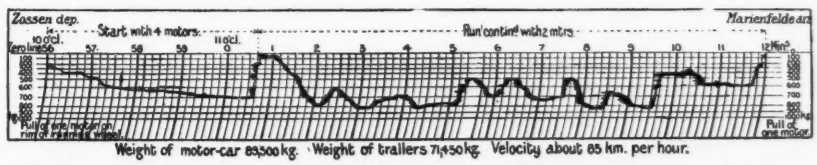


FIG. 14.—DIAGRAM OF THE TURNING MOMENT OF THE MOTOR, OBSERVED IN CAR "A" DURING RUN WITH FOUR SIX-WHEELED TRAILERS.

five per cent due, no doubt, to the losses in the starting resistances; but for long-distance traveling the period of acceleration is almost negligible. In tables A and B the results of these experiments are summarized, and diagrams in Figs. 8, 12

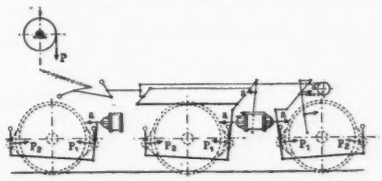


FIG. 15.—OUTLINE OF NEW BRAKE CONSTRUCTION.

and 13 give some details of runs with and without trailers. An attempt was made to measure the turning moment of a motor direct by fitting on car "A" a special apparatus represented in Fig. 10.

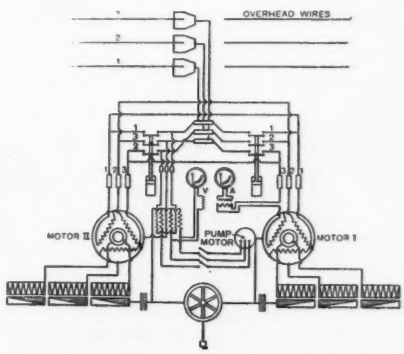


FIG. 16.—DIAGRAM OF CAR SWITCHING CONNECTIONS.

Instead of attaching the motor rigidly to the frame, it is held by springs, as shown diagrammatically, and the movement of the springs is transmitted by suitable levers to a registering indicator in the interior of the car. The instrument was calibrated by weights, and gave useful results when a resistance was inserted in the secondary circuit of the motor, but of course the direct comparison between the indicated turning moment and the electrical readings is thereby prevented. The diagram Fig. 14 shows the turning moment during a run of car "A" on November 8, and the curve, Fig. 11, is drawn in accordance with these indications. About the measurements made to ascertain the loss in feeders and conductors, nothing need be said, as no novel features with regard to them are disclosed in the report. Nor need the brake experiments be described, as they were again unsatisfactory, and eventually it was considered advisable to alter the whole of the braking arrangement. A good opportunity for doing this was afforded by the reconstruction of the bogies, which became necessary to ensure the steady running of the cars during high speeds.

In the new bogies the following points were to be observed: (1) the wheel-base is to be increased from 3.8 to 5 metres. (2) The bogie frames are to be constructed with simple Z girders. (3) The bearing springs are to be connected by balancing levers, and are to be visible and easily accessible throughout their whole length. (4) The car body is to be supported at four points on each bogie. (5) The centre pin of the bogie is to be movable for a distance of thirty millimetres in every direction. (6) The motors are to be connected to the axles by springs. (7) The brakes are to be reconstructed as shown in outline by Fig. 15, which explains itself.

During the trials the bending of the rails was measured in the same way as in the previous year; but as the speed of the cars had been restricted, no abnormal observations occurred and no extraordinary repairs became necessary. When the trial runs of the high-speed cars had been completed, some further experiments were made with a three-phase locomotive built by Siemens & Halske, and the Studiengesellschaft comments on them in a separate report. In this case they say that the high-speed cars have proved suitable for their work as far as their mechanical and electrical outfit is concerned, but their weight is too great and the proportion of their dead weight to the paying load is not favorable. The trouble with the permanent way and the very high power required during the acceleration period were a consequence of this weight, and for economical high-speed traffic it should, if possible, be diminished so as to load the axles only sufficiently for the necessary adhesion. It would not be possible to effect this object by altering the construction of the car or by lightening its mechanical outfit without endangering its safety. It is therefore necessary to try to diminish the weight of the electrical apparatus. This may be done by removing the transformers from the car and placing them along the line, or by dispensing with them altogether. In the first case a double set of conductors is required, increasing the losses and the capital expenditure. It is therefore preferable to employ motors which are capable of utilizing high-tension currents.

With a view of trying the possibility of using such motors on the high-speed cars, Messrs. Siemens and Halske built two motors of approximately the same outside dimensions, but suitable for working with 10,000-volt currents, and fitted them each to a four-wheeled bogie with a wheel-base of 3.25 metres. The car body, 12.5 metres long, is of the usual shape for electric locomotives, and in its centre is a driver's cabin, four metres long by 2.8 metres wide

TABLE A.

AVERAGE VALUE OF THE ELECTRICAL AND MECHANICAL MEASUREMENTS TAKEN DURING ACCELERATION.

No. of Runs.		No. of Motors Working.	Total Weight of Train in Tons.	Distance in Metres.	Falling Gradient. Average per Cent.	Average Acceleration. Mm./Sec.	Final Speed. Km./Hr.	No. of Periods per Sec.	At Feeding Point.			At Collector of Car.				Remarks
									Amp.	Volts.	Kw.	Amp.	Volts.	Kw.	H.-P.	
Car S	5	2	89.5	4,430	0.30	0.08	88.6	20.6	51.2	5,662	....	50.0	5,376	358	487	Car alone.
Car A	2	4	89.5	3,950	0.84	0.12	97.5	20.8	....	5,165	....	74.2	4,835	446	606	"
	6	2	89.5	7,930	0.54	0.07	106.0	24.0	51.1	6,383	....	50.1	6,024	407	553	"
	2	4	89.5	4 550	0.57	0.11	102.5	25.0		6,740		76.0	6,360	535	727	"
	3	4	188.4	8,700	0.61	0.07	113.3	25.0	101.0	6,253	880	....	....	813	1,105	Car drawing 3 pass. cars.
Car S	9	2	77.9	2.744	1.11	0.13	91.2	20.8	52.6	5.472	....	51.8	5,257	394	535	Car alone.
Car A	9	2	77.9	4,294	0.68	0.12	105.6	24.0	51.1	6,290	..	50.5	5,950	434	590	"
	6	4	159.6	5,583	0.60	0.11	116.7	25.0	108.2	6,237	1,010	105.6	5,938	928	1,261	Car and 2 pass. cars.
	1	4	193.4	8,300	....	0.07	115.0	25.0	110.0	6,140	988	107.0	5,450	855	1,160	Car and 3 pass. cars.

Observations taken in autumn, 1902.

TABLE B.

AVERAGE VALUE OF THE ELECTRICAL AND MECHANICAL MEASUREMENTS TAKEN DURING PERIODS OF RUNNING AT CONSTANT SPEED.

No. of Runs.		No. of Motors Working.	Total Weight of Train in Tons	Average Speed. Km./Hr.	No. of Periods per Sec.	At Feeding Point.			At Collectors of Car.				Efficiency of Electric Output. per Cent.	Power Exerted on Wheels.		Remarks.
						Amp.	Volts.	Kw.	Amp.	Volts.	Kw.	H.-P.		H.-P.	Pull in Kg.	
Car S	4	2	89.5	95	20.6	43.4	5,835	....	42.1	5,543	246	335	82.7	277	788	Car alone.
Car A	2	4	89.5	96	20.8	...	5,450	....	64.0	5,190	247	336	69.7	234	660	"
	5	2	89.5	107	24.0	45.6	6,460	....	43.8	6,089	302	410	86.4	354	892	"
	2	4	89.5	113	25.0	....	6,830	....	71.5	6,390	365	496	79.1	392	938	"
	2	4	188.4	117	25.0	84.7	6,647	694	....	....	644	875	87.1	762	1,760	Car and 3 pass. cars.
Car S	8	2	77.9	92	20.8	36.7	5,781	....	34.5	5,619	197	268	84.0	225	660	Car alone.
Car A	8	2	77.9	106	24.0	39.2	6,447	...	36.8	6,162	283	385	86.5	333	850	"
	4	4	159.6	117	25.0	69.2	6,937	566	65.0	6,685	499	679	85.5	580	1,330	Car and 2 pass. cars.
	1	4	193.4	118	25.0	81.5	6,700	713	75.0	6,425	680	925	87.7	810	1,840	Car and 3 pass. cars.

Observations taken in autumn, 1.02.

by 2.3 metres high. In the iron boxes on either side of it are the starting switches and resistances, and on the top it carries the collecting gear, which is like that of car "S." The motors are suspended from the bogie frames after the manner of tram motors, driving the axle by a gearing of one to two. Between the car body and the wheels are two sets of springs, and provision is made for a slight lateral movement relative to the bogie. The diagram (in Fig. 16) of the connections shows that there are separate switches, moved by compressed air, for each direction of running, a small transformer to supply low-tension current to the air-pump motor, and mechanical switches for the resistances which are actuated by a hand wheel in the driver's cabin, geared to a horizontal shaft. Some difficulties were experienced in obtaining readings of the measuring instruments on the locomotive of sufficient accuracy, so that finally only the measurements at the feeding point were taken into consideration.

The trial runs were started on June 23, 1902, with 7,250 volts, and this voltage was gradually raised until the locomotive successfully pulled a trailer on June 26 with just over 10,000 volts. Some of the details of the measurements taken during these runs are given in table C. It is at once apparent that the efficiency of the locomotive is much greater than that of the cars at the trials in 1901, for the reason that its motors were working nearer to their rated output. Another reason is the absence of a transformer, so that a comparison at an output of 400 horse-power shows that the locomotive required for this, at 10,800 volts and $\cos \Phi = 0.85$, an average current of nineteen amperes, while the cars at 6,300 volts and $\cos \Phi = 0.5$ consumed about fifty-three amperes. The losses in the conductors along the line are therefore two kilowatts in the case of the locomotive and seventeen kilowatts in the case of the cars.

In conclusion, the report considers that the trials have proved the possibility of building motors for three-phase currents of 10,000 volts, used direct without transformers. It is mentioned that the motors and the gearing have worked without giving any trouble up to a speed of 100 kilometres per hour, and that the working without transformers makes it possible to reduce the weight of the high-speed cars from ninety-two tons to seventy-six to seventy-eight tons, an achievement which will materially diminish the cost of working and the wear and tear of the permanent way. In the interval between the experiments of 1902 and those of last year, the permanent way of the line was renewed throughout, and now it is equal to that of a German first-class main line. The rails are twelve metres long, Vignoles pattern, standard profile eight; they weigh forty-one kilogrammes per metre, and are supported by eighteen sleepers bedded in stone ballast. As a matter of precaution, guard-rails were added all along the line, but it was evident, when they were carefully examined after the trials, that even at the highest speeds their service had never been required. Owing to the losses in the feeder and to the reduced speed of the generating sets, the acceleration could not be raised beyond 0.15 to 0.18 metre per second, although the motors on the cars would have been capable of developing more power than they actually did. The bogies of both cars were altered in accordance with the experience gained in previous trials, as requested by the syndicate. In the "A" car the switching arrangements were altered so that the motors can be strated one after the other instead of simultaneously, and further ventilation for the motors has been provided. The electrical arrangements of the "S" car remain exactly as they were made in the first instance; the motor casing, however, is now supported by springs from the bogie-frame, so that only the rotating part of the motors remains rigidly fixed to the axle.

An arrangement for measuring the turning moment by means of registering the pressure exerted by the casing on a piston working an oil manometer has been added to one of the motors of the "S" car, and also devices for diminishing the pressure on the brakes with diminishing speeds. All the exhaust openings of the Westinghouse brakes have been united by a common pipe on which two exhaust valves are fitted. One of these can be manipulated by the driver and the other is under the control of an electrical contrivance, the circuit of which is closed automatically by a pendulum weight when the retardation exceeds a certain rate. These additions had been found necessary as the pressure on the brake blocks at the highest speeds had to be equal to 200 per cent of the weight of the car, which at lower speeds would skid the wheels. For both cars the collectors were modified by dividing their horizontal arm into three parts, connected by springs, with a view of diminishing as much as possible the weight of the part receiving the blows caused by irregularities of the conductors and damping their effect further by subdividing the mass which has to be accelerated. In addition, the balancing wings which counteract the pressure of the wind on the collector arms were reconstructed with great care. A model of such a collector, kindly lent by Messrs. Siemens and Halske, was shown.

With regard to the general arrangement of the electrical outfit, the running of the cars at high speeds showed that the weights have to be distributed symmetrically on both sides of the car, in order to prevent excessive swaying. For this purpose balancing weights had to be added in the "A" car because the transformers had not been placed exactly symmetrically in the first instance. The actual runs began on September 15 with the "S" car, on which day a speed of 150 kilometres was reached, and the improvement in steadiness owing to the alteration of the bogies was most marked. During the following days the speed was gradually increased in the manner laid down in the original programme, until on October 6 a speed of 201 kilometres per hour was attained with a current of forty-six periods and 14,000 volts. It should be noted that in the curves with a radius of 2,000 metres the speed of the cars was restricted to 165 kilometres to 170 kilometres per hour, so as to avoid any danger. This point is in so far important as it shows that most of the existing main lines would be unsuitable for speeds greatly exceeding those of the present traffic.

One of the engineers, who was in the "S" car during the run, gives the following details:

"After examining the car and all the apparatus, the current was turned on until each of the motors was supplied with 350 amperes, corresponding to 2,300 kilowatts for the car. The feeding point, about one kilometre distant, was passed at the speed of eighty kilometres per hour; two kilometres, further 120 kilometres per hour was indicated; and at the first curve of 2,000 metres radius the speed was 170 kilometres; Mahlow, seven kilometres from Marienfelde, was passed at 185 kilometres per hour. Still the car is running quite smoothly, and all measurements can be noted down with greater comfort than in an ordinary express train. Keeping the power at 2,300 kilowatts the last resistances are gradually cut out and the speed increases to 195 kilometres per hour. Suddenly a sounding blow is heard against a window of the driver's cabin. It is no mishap to the car, but a bird is killed which has been overtaken by the car. At last one kilometre before

Rangsdorf, the indicator passes the 200 kilometres per hour mark, and for the space of another kilometre this speed is maintained, with an expenditure of 1,400 kilowatts. Then the brakes have to be applied, so that the car enters the second curve of 2,000 metres radius with a speed of 165 kilometres and arrives at the terminal station of Zossen eight minutes after leaving Marienfelde. An examination of the car shows it to be in absolute order, its front covered with bees, gnats and other insects, which appear as if smashed by a heavy weight—naturally, as the air-pressure rose to 210 kilogrammes per square metre. The recording speed indicator showed that the maximum speed had been 200.8 kilometres per hour."

TABLE C.

RUNS, AT CONSTANT SPEED, OF THREE-PHASE LOCOMOTIVE WITH ONE TRAILER.

Table C.—*Runs at Constant Speed, of Three-phase Locomotive with one Trailer.*

Date, June, 1902.	Run No.	No. of periods per sec.	Weight of train in tons.	Time of measurements in secs.	Speed in km. per hour.	Average at feeding point. Amp.	Volts.	Kw.	Average value of cos φ calculated.	Average power at feeding point.	Weight of trailer in kg.
23	I.	30	52·25	810	70	10·0	7,250	76	0·60	At 70km./hr. 91kw. = 124 H.P.	12,250
,,	II.	30	52·25	240	70	11·0	7,200	105	0·75		
24	I.	30	57·68	390	65–70	9·5	7,200	71	0·59		17,680
	II.	30	57·68	350	65–70	15·0	7,150	137	0·74		
25	I.	40	52·25	790	86	12·0	8,200	136	0·79	At 86km./hr. 184kw. = 250 H.P.	12,250
	II.	40	52·25	800	86	18·0	8,100	222	0·86		
	III.	40	52·25	760	86–88	13·0	8,250	150	0·81		
	IV.	40	52·25	820	86	18·6	8,150	226	0·86		
26	I.	47	70·75	410	101–102	20·5	10,650	322	0·84	At 102km./hr. 293kw. = 398 H.P.	30,750
	II.	47	70·75	390	102	18·5	10,850	286	0·285		
	III.	47	70·75	340	101·5–102	18·0	10,770	270	0·81		
	IV.	47	70·75	360	101·5–103	19·0	10,770	290	0·82		

TABLE D.

HIGH-SPEED RUNS.

Table D.—*High-speed Runs.*

Date, 1903.	Car.	Periods per sec. p.	Corresponding speed $V = \frac{1{\cdot}25 \times \pi \times 3{,}600}{3} \times p$.	Max. speed during run V.	Slip $\sigma = (V - V_1)/V$.
			Km. per hour.	Km. per hr.	Per cent.
Oct 28	A	47·5	223·84	210·2	6·0
Nov. 11	A	45·3	213·94	196·0	8·4
	S	45·3	213·94	208·0	2·8
Nov. 17	A	40·2	189·4	182·0	4·0
	S	40·2	189·4	184·0	2·8
Nov. 25	A	45·5	213·5	204·7	3·9*
	S	45·5	213·5	207·3	2·75

* The strength of the soda solution in starter had been increased.

dicator showed that the maximum speed had been 200.8 kilometres per hour."

After this memorable run further systematic measurements of air resistance, retardation, etc., were made, and the "A" car also began running. It made a record of 210.2 kilometres per hour on October 28, with a periodicity of 47.5 per second, all restrictions as to speed in curves being suspended on that occasion. During this run the car swayed so much that one of the conductors was broken and fell by accident on the foot of an official. The earthing device acted, however, so promptly that the man received no electric shock whatever. On the same occasion one of the transformers in the generating station was slightly damaged and in consequence the syndicate would not allow the car to run more than about forty-five periods per second for the subsequent trials.

Table D gives a summary of the most notable runs, comparing the theoretical speed, which depends on the number of periods, the diameter of the wheels and the number of poles (three pairs), with the actual speed, from which the slip can be calculated. The slip of the motors in the "S" car was uniformly 2.8 per cent, so that it would have run up to 217.6 kilometres per hour if it had been supplied with currents of 47.5 periods per second. It is, however, of no great moment whether a few kilometres more or less were accomplished by one or the other car; the important fact has been successfully demonstrated that trains can be constructed and worked by electricity at about double the speed of the present express trains, on a permanent way not materially differing from that of a first-class main line, except that it would not be safe to allow curves having a smaller radius than 2,000 metres in parts of the line where the trains have to run at full speed. In most cases it will, therefore, be necessary to build special lines for high-speed working, and no general rule can be established whether it would pay to do so. Although the experimental cars carried transformers and were equipped with three-phase motors, there is no necessity that these features should be repeated in the future. The trials of the locomotive in 1902 have shown that motors can be built for working direct with current of 12,000 volts, and the 1886 patent foreshadows the possibility of using induction motors with single-phase currents so that only one overhead line is required when the running rails are used for the return.

From the official report of last year's trial the tables E and F have been compiled, giving data during acceleration and during running at constant speed. It was found that an ordinary express car could not be used as trailer at speeds exceeding 180 kilometres per hour owing to excessive swaying, demonstrating the necessity of having a long wheelbase for the bogies and a symmetrical distribution of weights so that all wheels carry equal parts of the weight. Retardation experiments confirmed the formula previously found for the determination of air resistance, $P = 0.005\ V^2$, but it was incidentally mentioned by Colonel v. Scheve that for calculating the resistance of the air to projectiles the artillery officers used a formula of Newton's: $P = \frac{\Delta}{2g} V^2$ in which Δ is the weight of a cubic metre of air and V = velocity in metres per second. Taking the average value of $\Delta = 1.293$ and expressing the velocity in kilometres per hour, Newton's formula becomes $P = 0.0051\ V^2$, which agrees remarkably well with the formula deduced from the experiments. In concluding their report about last year's trials, the syndicate congratulate all those concerned on the successful achievement of the original problem, and announce their intention of continuing the trials in order to test the endurance of the various apparatus and to investigate the question of employing the single-phase motor.

TABLE E.

AVERAGE VALUE OF MEASUREMENTS TAKEN DURING ACCELERATION.

	Date, 1903.	Level above ordnance datum. Start.	Finish.	Acceleration. Time in sec.	Dist. in metres.	Av. rate.	Final speed Km.-hrs.	Periods per sec.	At feeding point. Amps.	Volts.	Kw.	At collectors of car. Amps.	Volts.	Kw.	Cos φ.	Kw.-hours.	H.P.	Wind. Direction.	Velocity.
Car A, 94,000kg.	a Oct. 28	48·14	42·8	360	13,450	0·162	210·0	48	132·0	10,401	..	132·0	10,110	2,040	0·88	205·0	2,770	E.	1·6
	a Nov. 12	40·05	42·3	393	12,580	0·123	174·0	40	112·0	9,840	1,570	112·0	9,000	1,440	0·825	162·0	1,960	W	4·8
	a ,, 14	48·14	45·1	220	5,380	0·197	156·0	36	118·0	8,910	1,426	118·0	8,910	1,390	0·765	98·0	1,890	E.	3·5
	b ,, 17	48·14	42·1	360	10,100	0·134	174·0	40	146·0	8,750	1,840	146·0	8,670	1,760	0·80	186·0	2,320	S.S.W.	3·2
	c ,, 20	48·14	39·6	270	8,510	0·185	180·5	40	126·0	9,925	1,650	124·0	9,810	1,590	0·756	126·0	2,160	N.N.E.	2·6
	a ,, 20	48·14	47·35	280	8,520	0·178	180·0	40	114·0	9,850	1,600	117·0	9,705	1,570	0·80	131·0	2,140	N.N.E.	2·6
	e ,, 25	40·05	47·6	365	12,280	0·151	205·0	46	126·0	10,980	1,935	126·0	9,840	1,760	0·82	186·0	2,350	S.W.	3·2
Car S, 93,400kg.	Oct. 23	40·05	47·0	374	14,250	0·153	206·0	46	134·4	12,015	2,820	134·2	10,160	2,130	0·9	220·0	2,900	S.S.W.	4·9
	,, 26	40·05	42·2	410	12,450	0·123	180·0	40	113·5	9,380	1,520	113·3	8,050	1,416	0·9	161·2	1,935	S.E.	3·3
	b Nov. 13	48·14	42·14	350	10,050	0·114	162·0	36	125·2	9,120	1,650	124·8	8,900	1,573	0·815	153·6	2,135	E.S.E.	3·3
	,, 13	48·14	48·93	230	6,230	0·196	162·0	36	120·0	8,865	1,625	119·5	8,730	1,490	0·825	98·2	2,020	E.S.E.	3·3
	,, 25	48·14	42·2	400	15,100	0·145	209·0	46	134·3	10,630	2,090	134·0	10,240	2,010	0·845	223·0	2,730	S.W.	3·2
	,, 26	48·14	48·2	265	7,595	0·178	170·0	40	115·5	9,190	1,530	114·0	9,000	1,490	0·839	109·6	2,030	S.W.	5·9
	,, 26	48·14	48·0	280	7,650	0·181	170·0	40	118·0	9,040	1,550	117·7	8,785	1,520	0·853	109·8	2,070	S.W.	5·9

a Without bow fitting. *b* With sleeping car (44,300kg.). *c* With bow fitting.

TABLE F.

AVERAGE VALUE OF MEASUREMENTS TAKEN WHILE RUNNING AT CONSTANT SPEED.

	Date, 1903.	Average speed. Km.-hr..	No. of periods per sec.	At feeding point. Amps.	Volts.	Kw.	At collectors of car. Amps.	Volts.	Kw.	Cos φ.	H.P.	Power exerted on wheels calc. for level, calm and cos φ = 1·83. Per run.	Average.
Car A (94,000kg.)	a Oct. 22..	172·5	40	100·0	9,855	1,335	100·0	9,360	1,295*	0·795	1,745	1,389	..
	a ,, 24..	177·5	40	97·0	10,490	1,320	96·0	10,035	1,045	0·630	1,420	1,168	..
	a Nov. 14..	163·0	36	85·0	9,640	1,035	84·0	9,180	955	0·715	1,230	1,114	1,074
	a ,, 14..	163·5	36	81·0	9,460	980	80·0	9,110	935	0·740	1,270	1,034	..
	b ,, 17..	175·0	40	109·0	9,870	1,575	108·0	9,860	1,460	0·885	1,985	1,496	1,544
	b ,, 17..	168·5	40	113·0	9,670	1,590	(113)	9,800	1,450	0·800	1,970	1,589	..
	c ,, 19..	178·5	40	94·0	10,400	1,250	92·0	10,080	1,305	0·758	1,640	1,363	..
	d ,, 20..	182·0	40	93·0	10,930	1,170	89·0	10,560	1,080	0·655	1,470	1,363	1,814
	d ,, 20..	180·0	40	92·0	10,700	1,240	91·0	10,275	1,185	0·733	1,610	1,265	..
	c ,, 20..	182·0	40	93·0	10,500	1,350	90·0	10,200	1,160	0·730	1,575	1,511	1,435
	e ,, 20..	181·0	40	94·0	10,300	1,300	93·0	9,900	1,230	0·780	1,610	1,360	..
	e Oct. 26..	180·0	40	103·1	9,630	1,125	102·1	9,000	1,380	0·860	1,675	1,835	..
Car S (93,400kg.)	b Nov. 13..	163·0	36	102·8	9,600	1,382	101·8	9,000	1,269	0·800	1,720	1,322	1,325
	b ,, 13..	161·0	36	109·0	9,200	1,450	108·0	8,600	1,380	0·857	1,875	1,329	..
	e ,, 13..	165·0	36	86·0	9,700	1,060	85·4	9,310	1,000	0·724	1,355	1,164	1,349
	e ,, 13..	165·0	36	83·2	9,530	1065	83·0	9,100	1,010	0·770	1,372	1,155	..
	e ,, 14..	165·0	36	88·0	9,400	1,100	87·4	8,900	1,040	0·770	1,412	1,203	1,146
	e ,, 14..	165·0	36	83·0	9,440	1,030	82·4	9,000	1,000	0·777	1,355	1,089	..
	e ,, 23..	168·8	36	85·4	10,150	1,100	83·5	9,700	1,040	0·740	1,412	1,287	..
	e ,, 23..	168·0	36	84·5	10,100	1,080	83·7	9,600	1,020	0·730	1,385	1,250	..
	e ,, 26..	172·0	36	87·4	10,250	1,140	86·9	9,420	1,080	0·762	1,465	1,179	1,266
	e ,, 26..	171·5	36	90·0	10,000	1,195	89·5	9,556	1,145	0·776	1,555	1,334	..
	e ,, 26..	171·5	36	87·0	10,050	1,125	86·5	9,540	1,070	0·750	1,453	1,166	1,254
	e ,, 26..	171·0	36	88·5	9,800	1,180	88·0	9,300	1,140	0·805	1,550	1,343	..
	e ,, 26..	171·5	36	85·6	9,900	1,090	84·2	9,350	1,050	0·770	1,425	1,140	1,252
	e ,, 26..	170·5	36	92·0	9,640	1,210	91·5	9,060	1,170	0·810	1,590	1,365	..

a Without wedge-shape bow fitting. *b* With sleeping car (44,300kg.). *c* Without bow fitting. *d* With bow fitting. *e* Car by itself.

The Testing of Meters for a Central Station Meter Department.

In an elaborate and interesting paper read before the Incorporated Municipal Electrical Association, London, England, on June 29, under the title, "The Organization and Management of a Central-Station Meter Department," Mr. A. J. Cridge, Sheffield, makes the following suggestions with regard to the work of testing in connection with meters:

For the purpose of controlling the supply of electricity for testing a switchboard will be required. The one here described controls a maximum supply of ten kilowatts—*i. e.*, fifty amperes at 200 volts single-phase alternating current. By means of a suitable transformer it is possible to get almost any voltage from twenty-eight to 300 by altering the connections. This is done by causing the turns on the secondaries of the transformer to help or to oppose each other. Similarly, it is possible to get any current up to 300 or 400 amperes. The link connectors of the transformer therefore give a coarse adjustment, and the fine adjustment is made by means of suitable rheostats. The voltage is measured by Kelvin voltmeters, the current by Kelvin ammeters, and the wattage by a Kelvin balance. There are six main circuits, which branch off from the switchboard as follows: (1) experimental, (2) rheostat (large), (3) rheostat (small), (4) meter bench (one), (5) meter bench (two), (6) main coil of Kelvin balance. These are put in or taken out of circuit by plugs, and the ammeters are connected by plugs with flexible conductors attached. There are twelve pressure circuits provided, six on either end of the board. Only four of these are in use on one end and three on the other. They are as follows: I. (1) meter bench (1) top shunt circuit, (2) meter bench bottom shunt circuit, (3) experimental, (4) photometer; II. (1) meter bench (2) top shunt circuit, (2) meter bench bottom shunt circuit, (3) shunt of Kelvin balance. Two-pin plugs are placed across each of the main circuits for the purpose of measuring the pressure between any pair of circuit leads or absorbed in any piece of apparatus. The use of the main circuits is: (1) Experimental.—A pair of heavy cables run to a pair of big terminals on a bench. The current and the pressure can be adjusted to any figure desired, so that the circuit may be used for any purpose. (2) Rheostat (large).—This is for the control of currents up to 125 amperes. It consists of carbon plates, and the resistance is increased or diminished by slackening or tightening a screw. (3) Rheostat (small).—This is for the adjustment of small currents, from 0.1 to five amperes. (4) and (5) Meter Benches.—These are arranged to hold a total of forty-eight meters. The meters are placed in position on the bench and the series coils are disconnected from the shunt coils. The series coils are then connected to terminals on the bench by flexible connectors and the shunt coils joined across the proper pressure circuits by small flexibles, to which are attached two-pin plugs. Attention has been given in the design of these benches to the need of fixing up a number of meters for testing in the most expeditious manner possible. All connections are made by plugs or clips. To join up any terminals not in use, copper bridge pieces are employed. (6) Main coil of Kelvin balance.—The balance shunt coil is disconnected from the current coil, and the latter, which constitutes circuit 6, is plugged in in series with the meter benches and rheostats. The shunt coil is connected across pressure circuit II., sub-circuit 3. The use of the pressure circuits is almost obvious. On circuit I. the first two sub-circuits are for the shunts of meters connected to the top or bottom racks of meter bench I. The third sub-circuit consists of a pair of leads which run to two terminals on the working bench, and to which may be connected any apparatus which does not take very much current. The most frequent use to which it is put is that of running incandescent lamps which are undergoing a life test. Sub-circuit 4 belongs to the photometer, to which reference will be made under the heading II. 3. Two sub-circuits are not yet in use. On circuit II., the first two sub-circuits supply the shunts of meters on meter bench II., and the third is the shunt of the Kelvin balance. There are therefore three spare ways on this circuit. The testing of meters is carried out as follows: A number of meters having been joined up in series on the benches with their series coils disconnected from their shunt coils, the current flowing through them is adjusted by means of the rheostats and measured by the balance. A few revolutions of the disc are observed, and the time taken is noted by means of a chronograph. The testing constant of the meter being known, the percentage accuracy can be calculated from these observations. The practice seems to be becoming general among meter makers of constructing all their meters in such a manner that the disc revolves a certain round number of times per minute at full load. Thus Ferranti meters make forty revolutions per minute at full load, Westinghouse and Schuckert fifty, Electrical Company sixty. Other makes of meters have a constant marked on the dial, giving the number of watts which cause the disc to make one revolution in an hour. Thomson-Houston meters form a well known example of this kind. A few words on the different kinds of meters will not be out of place here, but it is difficult to say anything new on this subject. The object of this paper is not to say which type of meter is best nor to go into many constructional details. It will suffice to say that any induction meter which is suitable for inductive as well as non-inductive load is usually good. The day of meters with commutators is over; there are now so many good types of induction meters which are greatly superior if only for this reason. The Aron meter is good, but the winding gear has been found to give a lot of trouble on alternating-current circuits; the contacts get dirty because of the sparking which takes place so frequently. Some meters are now constructed with cyclometer dials, and most manufacturers are willing to supply their meters fitted in this way. These are infinitely to be preferred to the old type; the possibility of error on the part of the meter reader is entirely eliminated, and consumers like them because they are easier to read, and they are thus enabled to check their consumption. It will be seen by making a small calculation that testing meters as described above is far more economical than the old-fashioned method of using a bank of lamps. A ten-ampere meter under the old method required two kilowatts at full load, the pressure being assumed at 200 volts. By the use of the transformer we have ten amperes at twenty-eight volts = 280 watts, plus, say, four to six watts in the meter shunt, or a saving in power of nearly eighty-seven per cent. This saving will amount to a considerable number of units during a year.

Fixing Meters—The meter, after being tested and adjusted, is sent out to an installation. The meter reader has to note the reading of the old meter, take out the fuses, take down the old meter and fix the new one, replace the fuses, note the reading of the new meter, and try it for starting with an eight-candle-power lamp. If it is a new installation, he has not to put in the fuses nor to try the meter, this being the duty of the testing inspector.

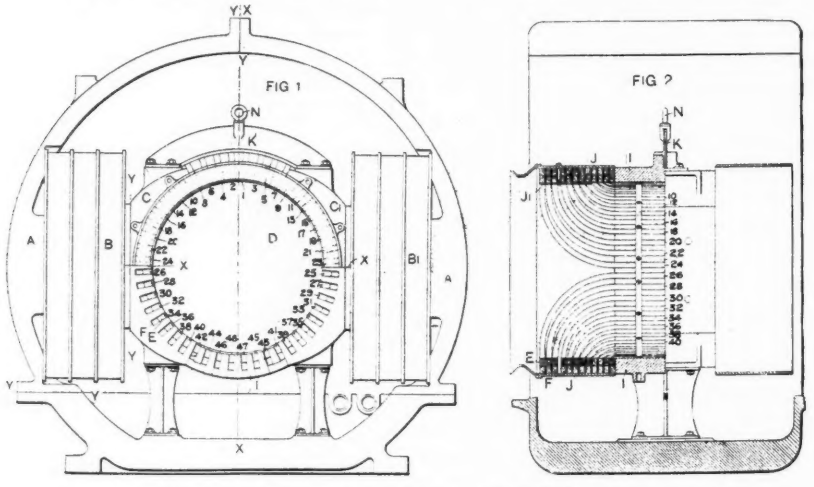
The maintenance of the station meters is an important matter, and they should receive frequent attention. It is useful for many reasons to know the total number of units generated; the works costs, percentage of waste, etc., are all determined from this total. A small error in large meters such as these makes a lot of difference, and great care should therefore be taken that these meters are kept in an accurate and satisfactory condition. Demand indicators are not in use at Sheffield, but for the purpose of testing these a circuit would be run to a suitable rack, and the indicators would be connected in series and set to zero. The required current would be passed through them for thirty or forty minutes, and readings would be taken. The necessary adjustments would be made from these observations.

Parsons & Stoney's Continuous-Current Dynamo.[1]

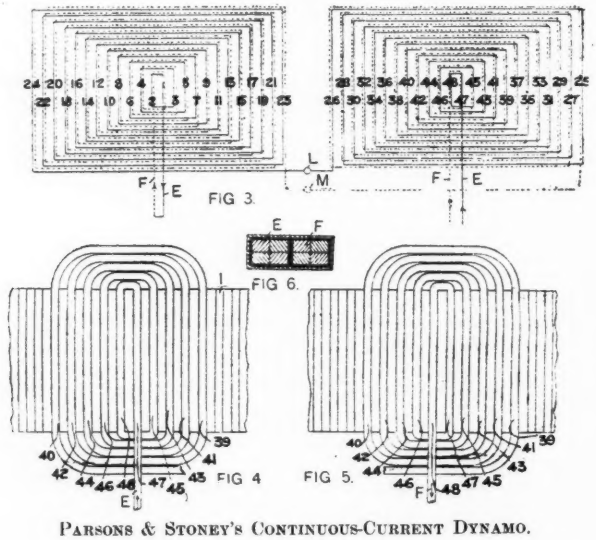
The accompanying illustrations show the construction of a continuous-current dynamo, the joint invention of the Hon. Charles A. Parsons and G. G. Stoney, of Heaton Works, Newcastle-on-Tyne, and which possesses several novel features, the chief of which are (1) a practically fixed line of commutation at all loads without sparking; and (2) an increase in the allowable ampere-turns per inch diameter of the armature, so that an increase of output of at least two or three times may be obtained from a machine of given size. Further, provision is made for the ready removal of the armature when required. Fig. 1 is an end view of the machine, the position of the winding being indicated in the slots 25, 26,—47, 48. Fig. 2 is a side elevation partly in section on the line XX, Fig. 1; the winding being shown diagrammatically and the shunt coils being removed. Fig. 3 is a diagrammatic view of the winding; the right-hand spiral being a plan of a lower half of the winding and the left-hand spiral an inverted plan of the upper half. Figs. 4 and 5 are developed views of part of the winding. Fig. 6 is a section of the conductors and insulation.

Referring to the illustrations, AA are the field magnets, wound with divided shunt coils BB. The pole pieces C_1C_1 are divided along the XX, Fig. 1. The fixed series winding is placed round the space D in which the armature revolves. The winding consists of two coils in series with the armature, the form of the winding being that of spirals on a cylindrical surface closely surrounding the armature but giving clearance for its revolution. The coils EF where they occupy the polar faces are embedded therein in open slots 1, 2, 3, 4, etc., and between the polar faces are carried by non-magnetic segments I grooved for their reception. Beyond the magnets at each side the conductors pass in a direction perpendicular to the axis of the armature and are carried by cylindrical extensions JJ. The coils are shown diagrammatically in Fig. 3. The first coil E lies nearer to the armature in the slots, while the second coil F lies parallel with the coil E in the slots but takes a different path between them, as shown in the developed views Figs. 4 and 5; the true-developed view from the inside being obtained by superposing Fig. 4 on Fig. 5. The first coil E passes from front to back through the slot 47, from back to front through 48, and from 48 through 45, 46, etc., to 26, from back to front through 26, and from the front of 26 by the connection L to the back of 24 (see the left-hand bottom corner of the diagram Fig. 3, in which the left-hand spiral is an inverted plan of the upper half of the winding), and then through 24, 23, etc., round the upper half of the armature to 2, 1. The second coil F joins the first at the back of slot 1, passes through 2, from back to front, and from 2 through 1, 4, 3, 6, 5, etc., to 23, through 23 from back to front, from the back of 23 to the front of 25 by the connection M, through 25 from front to back, and from 25 through 26, 27, 28, etc., to 48, which is the end of the second coil. The coils E and F are shown in full and dotted lines respectively in the diagram Fig. 3. The current in the part of each coil in any slot in or between the pole-faces will be opposite in direction to the current in the adjacent conductors in the armature.

Fig. 6 shows a section of the conductors which lies in the slots as indicated in the lower half of Fig. 1. The coils E and F are divided along a horizontal diameter XX, Fig. 1; the upper half 1, 2—23, 24, fits in the half-pole pieces CC_1, and is also supported by the brass-connecting piece K and extensions J. When it is desired to remove the armature the field-magnet A with the shunt coils B are removed, the line of separation being marked by the dotted line YY in Fig. 1. The binding screws LM connecting the upper and lower parts of the coils EF are then loosened, and the upper half of the coils with the piece K and extensions J can be lifted out by the eyebolt N. The polar plane of the coils CF coincides with the plane of commutation of the armature at no load.



PARSONS & STONEY'S CONTINUOUS-CURRENT DYNAMO.



PARSONS & STONEY'S CONTINUOUS-CURRENT DYNAMO.

[1] *Mechanical Engineer*, London, England.

Electrical Industries in England.

It is reported in the British *Trade Review* that work is fairly plentiful in the electrical engineering shops through South Lancashire. This is chiefly for traction and power appliances. A large contract was recently secured for laying the Royton-Crompton electric railways. The offer of Messrs. Underwood Brothers, of Dukinfield, was accepted. This was $205,000.

Improving Electric Lighting Service.

At a recent meeting of the Incorporated Municipal Electrical Association, of England, an address was given by the president, Mr. T. P. Wilmshurst, which dealt principally with questions of local interest only, but the following excerpt is of more general interest:

The growth of our business, as shown in the periodical returns which are available, is very satisfactory. It is advisable, however, to remember the great progress which is also being made by our competitors. In recent years the gas business has received an enormous impetus from the introduction of the Welsbach mantle, and it would be folly on our part to disregard their experience. Rather let us see if the methods they adopt can not also be adopted with benefit to ourselves.

When the old flat-flame burner was in general use the burner was of the simplest possible character, and if kept clean would last an indefinite time without attention. The old order, however, changed with the extended use of the Welsbach mantle. This gradually deteriorates with use and has to be replaced at more or less frequent intervals. Neglect of this results in discredit being thrown on the supply. Gas engineers have not been slow to see that for the credit of their undertakings some sort of supervision of the consumers' fittings is to the interest of both buyer and seller. We find, therefore, an increasing tendency for arrangements to be made whereby, for a small payment, a periodical inspection is given.

Now, the position of the incandescent electric lamp is analogous to that of the mantle. It is a device requiring technical knowledge in its selection, so that lamps of reasonably high efficiency and long life may be used. Yet how many of our consumers consider life and efficiency before first cost when purchasing?

The result is, inefficient lamps are used and are allowed to burn beyond the "scrapping point," and heavy bills follow; the supply is blamed as "not being so good as it used to be," and strained relations arise between our consumers and ourselves. I believe, therefore, that if we wish to continue and increase our rate of progress, the following suggestions are worthy of consideration:

1. The periodical renewal of consumers' lamps, free, or on easy terms;

2. The periodical inspection of consumers' lamps *in situ;* or

3. The free testing of, and reporting on, consumers' lamps.

I am aware that there are deeply rooted objections to the first two courses. Many engineers (and their consumers) shrink from organized domiciliary visits and from interference of any sort beyond the meter. Another objection often urged is that we do not purvey light, but electrical energy, and consequently it is no concern of ours how that energy is used.

Though I have no sympathy with the principle of the municipality undertaking wiring or interfering with the legitimate business of the local contractor, I believe that only good can result from our selling lamps of good efficiency at the lowest possible price. The opponents of municipal trading will, I think, admit that this is germane to the business of electricity supply, and parliament has recognized this by permitting in many local acts the clause authorizing us to "sell, let on hire, and otherwise deal with electric lamps," etc.

Personally, I am strongly in favor of the policy of testing free of charge all lamps which the consumer likes to send us: the expense to us is very small, and there should be no difficulty in arranging for the tests to be carried out during the night shift or some other convenient time.

Magnetism and Planetary Bodies.

To the Editor of the Electrical Review:

An interesting paragraph in the *Scientific American* supplement, July 16, suggests the thought that through the experiments of J. J. Thomson we may soon establish a universal law.

J. J. Thomson agrees with Professor J. H. L. Vogt, of the University of Christiana, who has concluded that magnetic properties of bodies can not be explained if force is proportioned to the distance from a fixed point.

It has occurred to the writer that the square root of distance may be the key which shall unlock the universal law. The square root of distance is accepted for the pendulum, and it would seem to be but a step in experiment to apply the same to bodies or atoms spinning, and at the same time revolving around a uniform central magnet.

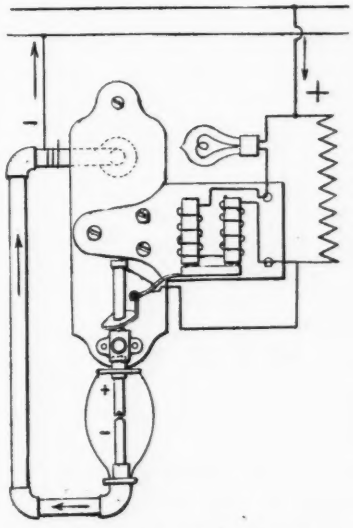
The application of this key seems to lead to a law governing gyroscope planets and all atoms for infinite distances, while revolving in the same plane. On reflection, possibly the cube of the square root of radius may be equivalent to the unit of orbital time; and if such be the truth, then the fundamental unit will change to time—matter—motion.

Emma Durant.

New York, July 15.

An Arc Lamp for Amateurs.

An ingenious type of arc lamp has been devised by M. G. W. Walsch, which can be made by any amateur, the only apparatus necessary being an electric bell, an incandescent lamp, some resistance wire and the necessary carbons. The arrangement is described by M. Armand Lehman in the *L'Electricien* (Paris) for July 2, from which the accompanying illustration is reproduced. The magnets of a five-inch bell are used, the coils being mounted in series with a sixteen-candle-power incandescent lamp. In parallel with these is placed a resistance of about twenty-five ohms, which may be made up of any convenient resistance wire or of a number of incandescent lamps in parallel. One end of this double circuit is connected to the positive side of the supply circuit, the other end being connected



An Arc Lamp for Amateurs.

to the upper carbon. The lower carbon is connected to the negative side of the supply by means of a half-inch pipe. The upper carbon slides through a small guide, and is gripped by means of a flat washer which fits over it loosely. One side of this washer is attached by a small cord to the hammer of the bell. The lamp is regulated by adjusting the resistance shunting the bell magnet.

In operation, when the circuit is closed, the upper carbon rests upon the lower. Upon closing the circuit, the current passing through the bell magnets raises the washer surrounding the upper carbon, gripping the carbon, and drawing it up strikes the arc. When the arc becomes too long, the decrease in the current through the magnets allows the upper carbon to fall, and the lamp thus readjusts itself.

COMMERCIAL PRACTICABILITY OF ELECTRIC TRACTION BY SURFACE CONTACTS.[1]

BY C. E. C. SHAWFIELD.

The surface-contact system in operation at Wolverhampton was first introduced into England by the Lorain Steel Company of America, who had previously experimented with the system at Washington. It was first brought before the notice of the Wolverhampton Tramways committee in March, 1901, and after lengthy negotiations a contract was entered into between the corporation and the Lorain Steel Company by which the latter were to equip about eleven and one-half miles of single track with their surface-contact system, and allow the corporation to operate the lines so equipped for a period of twelve months. It was a condition of the contract that if the system proved itself a commercial success during the period of experimental operation, the corporation were to take over and pay for the same at an agreed upon rate, but if it failed to prove itself safe and reliable and commercially successful, the Lorain Steel Company were to remove their apparatus and bear the whole cost of the experiment. The twelve months' experimental operation terminated on April 17, 1903, and although there was a great deal of difference of opinion in the town council as to the advisability of retaining the system, it was eventually decided on September 11, by a large majority, that the system should be accepted. Shortly afterward it was decided to proceed with the reconstruction of existing routes operated by horse traction and the construction of new routes, amounting in all to an additional seven miles of single track, and the council decided that these extensions should also be equipped with the Lorain surface-contact system. About five miles of these extensions have already been completed, and it is expected that the remainder will be finished very shortly.

A total of 109 boxes were found more or less alive during twelve months, fifty-nine of which were alive at an electromotive force of over fifty and under 500 volts. The author has divided the live boxes into two sections—namely, those under and those over fifty volts—as he had found by experiment that it is quite impossible for any person or animal to feel the slightest sensation of shock from a box which gives a reading of fifty volts or under, and it is only in rare cases that anything approaching a shock can be obtained from a box which gives a reading of less than 100 volts.

Out of a total of 173 car-miles lost due to defects in the Lorain surface-contact equipment during twelve months, only twenty-seven are debited against the track equipment; these were due to the following causes: three car-miles were lost owing to a delay arising from an improperly soldered joint in a cable terminal, the remaining twenty-four miles being lost owing to a top-plate situated very close to a cross rail being permanently earthed thereto by a piece of iron wedged between the plate and the rail, it being about twenty minutes before the source of the trouble was discovered. One hundred and forty-six car-miles lost due to defects in the car equipment.

The total number of car-miles lost due to defects in the electrical equipment of both cars and track averaged three and one-third car-miles out of every 10,000 run, and having regard to the fact that during the months of February and March there were frequent and heavy snowfalls, the author is of the opinion that this constitutes a record of regularity of service which it is difficult to surpass. In considering the car-miles lost due to the Lorain car equipment, it must be remembered that the defects which were the cause of the delays have a parallel in the case of the overhead system in respect of broken and damaged trolley wheels and trolley poles and in the earthing of the cables inside the trolley standard.

The whole of the work of inspection and testing of the electrical equipment of the track, the removal and replacement of faulty boxes and the execution of all repairs of every kind required in connection with the maintenance of the electrical equipment of the fifteen miles of single track is performed by two men, who are paid wages of thirty-two shillings and twenty-eight shillings per week respectively. The working day of approximately seventeen hours is divided into two shifts, so that there is only one man on duty at a time. Every box is tested once a week, and the boxes in the vicinity of points and crossings and other special track work where there is a liability to short-circuits are tested daily.

The expenditure on the inspection and maintenance of the car equipment has been rather heavy, the items relating to the magnet systems and batteries being, in the author's opinion, abnormal, and considerably in excess of what may be expected in the future.

One of the most serious disadvantages of the surface-contact system is the increased consumption of electrical energy involved. The additional quantity required varies according to the type of surface-contact system adopted, but with practically every type of system there are three causes which must involve additional current consumption, and these are as follows:

1. The energy required to operate the circuit-closing mechanism of the track equipment.
2. The additional energy necessary for the propulsion of the cars owing to the extra weight of the special apparatus carried on the car.
3. The surface leakage from box to rail over the paving under each car on the track.

Of the above-mentioned sources of power waste the first two only need be seriously considered, as in the case of the third the amount of energy wasted by surface leakage is so small as to be negligible.

In the case of the Lorain system as installed at Wolverhampton, the current required for the operation of the circuit-closing mechanism in the track equipment, which is in this case the energy required for the excitation of the magnets, represents a power consumption of 670 watts per hour, which is equivalent under ordinary conditions of service to 0.11 unit per car-mile.

The additional energy required to propel the cars owing to the extra weight carried must, of course, vary in different localities, being obviously more in a hilly district than in a flat. It would also be affected to a certain extent by the type of rolling stock in use and the distance apart of the stopping places. It is, therefore, impossible to give a general estimate as to the additional energy consumed under this heading.

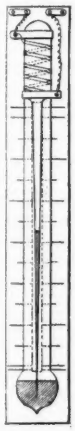
It is very difficult, if not impossible, to give a general figure for the difference in first cost of the overhead system and the surface-contact system, owing to the fact that while the cost of the former is practically the same for either double or single track, the cost of the electrical equipment of the latter is obviously twice as much for double track as for single. Consequently, the amount of the extra cost of installing a surface-contact system necessarily depends upon the proportion of double to single track on the routes concerned.

During the two and one-half years that the system has been in operation no complaint of any kind has been received as to any obstruction or inconvenience to traffic having been caused by the iron top-plates in the street surface, and, so far as the author is aware, no accident of any kind has ever been attributed to them. There is, moreover, no indication of any abnormal wear of the paving surrounding the studs, neither wood nor granite paving in the immediate vicinity of the metal top-plates appearing to wear any faster than at other parts of the track.

[1] Abstract of paper read before the Incorporated Municipal Electrical Association, London, England, June 29.

Electrical Patents.

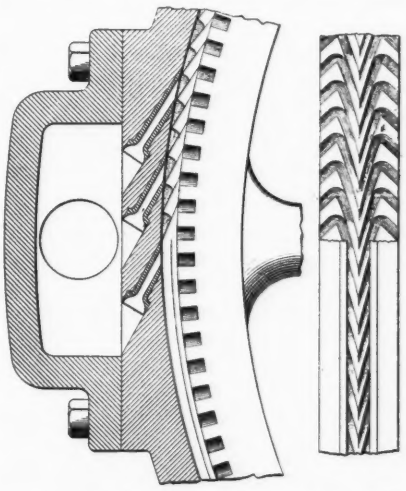
Signor Carlo Clerici, a native of Milan, Italy, has invented certain improvements in electricity meters. The invention has relation to that class of electricity meters which are based on the expansion of a volume of gas when heated by means of a coil through which the current to be measured or a current proportional thereto is caused to flow. This meter may be used either as an ammeter or voltmeter or volt-ammeter, both for direct reading and also as a maximum-demand



New Form of Electricity Meter.

indicator, the latter being the use for which the apparatus is specially intended. In other maximum-demand indicators heretofore known wherein a suitable liquid acts as a seal preventing the escape of the gas, the heating of a bulb by means of a coil through which the current to the consumer is taken, has been availed of; but these prior apparatus are based on the principle of forming a trap which catches the liquid that overflows when the bulb is warmed by the current flowing through the coil. According to the present invention, the liquid, on the contrary, always forms a continuous column and is never parted by the action of the current into two separate bodies. In the embodiment of the invention, a glass bulb is employed which is connected with a tube, tapering downward, whose lower end enters another bulb containing a suitable liquid, but not filled therewith. The tube and the second bulb are welded together, the open end of the tube dipping into the liquid contained in the bulb. On heating the first bulb, the gas contained therein expands and finds its way out the orifice of the tube, rising in bubbles through the liquid. The bulb being allowed to cool, the equilibrium will be restored as soon as a quantity of liquid proportional to the quantity of gas driven out of the bulb, and therefore to the whole quantity of heat received by the bulb, has arisen along the tube to a predetermined level.

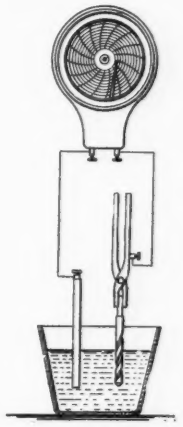
The Westinghouse Machine Company is the assignee of a patent recently obtained by Mr. Francis Hodgkinson, of Edgewood Park, and Mr. Otto Frik, of Wilkinsburg, Pa., on an impulse wheel for fluid pressure turbines. The body or rim of the impulse wheel is provided with a circumferential series of duplicate steam receiving passages or buckets, the receiving portions of which have common inlet openings at the periphery of the wheel and diverge forwardly and at gradually increasing depths to points which are approximately half way between the central plane and the outer sides or faces of the wheel, though the exact points at which the portions of the passage terminate are not material. From the points, the portions of the passages extend outwardly and rearwardly to the side faces of the wheel, either at a uniform or at varying depths, as desired. In the present embodiment, the portions of the passages are of uniform width, since they are severally formed by means of a suitable milling cutter, which moves and is suitably guided during the cutting operation from one end to the other of the passage, so as to form it at a single operation. All but the inlet ends of the passage are covered



Impulse Wheel for Fluid Pressure Turbines.

by shrouds which are placed in position after the passages are completed, but a stationary casing might be formed to so fit the wheel that the shrouds could be omitted. The wheel is mounted and rotates in a casing, which is provided with a steam box and with suitable nozzles, leading therefrom to the adjacent portion of the wheel periphery, the steam being expanded into and discharged from the nozzles at high velocity. As the steam is discharged, it is divided by sharp edges formed by the passage, and as it reaches the points of the passages, it imparts its velocity to the wheel and exhausts in a lateral and rearward direction through the portions of the passages. The number of nozzles may be obviously varied from what is shown and the form and relation of the several parts be otherwise modified within reasonable limits. The wheel may be used either alone or in conjunction with other steam-using means into which the steam is exhausted from the passages.

A thermoelectric apparatus, particularly adapted for indicating, in connection with a suitable electric-measuring



Thermoelectric Apparatus.

instrument, the temperature of an article to be heated or otherwise treated in a bath, has recently been patented by Mr. William H. Bristol, of Hoboken, N. J. The thermoelectric couple comprises two elements, one of which is wholly or partly formed by the articles to be heated or otherwise treated in a bath. A receptacle in the form of a pot or crucible is employed and is heated in the usual manner. The electric-measuring instrument is in the form of an indicating or recording instrument, such, for instance, as a voltmeter of any suitable construction, to the binding-posts of which the elements are connected by wires. The second element is held by a pair of tongs of a form adapted to hold the article to be treated and made of the same material as the article so as to avoid the formation of auxiliary couples. These tongs are connected by wire with the measuring instrument. The pyrometer so formed is used to indicate the temperature of drills when placed in the tempering bath, the bath forming the electrical connection between the drill and the other element at the hot ends. By this means the exact temperature of the drill is indicated by the measuring instrument and it can be removed when it has reached the desired temperature. Heretofore, only the temperature of the bath, and not that of the article, was ascertained. To save wear on the first element of the thermoelectric couple, it can be connected to the other element by means of a clamp of non-conducting material, thus causing it to be removed with the article.

Reviews of Current Engineering and Scientific Literature.

Suppression of Magnetic Hysteresis.

An investigation of the several methods of reducing magnetic hysteresis has been made by M. C. Maurain, who here describes his work and gives the results of the experiments made. Four electrical methods were tried, and one mechanical. The electrical methods were: the action of an alternating field having the same direction as the magnetizing field; the effect of an alternating current flowing through the iron itself; the action of magnetic oscillations having the same direction as the magnetizing field; the action of electric oscillations in passing through the iron. The mechanical method was to set up vibrations by jarring the iron. The results show that all of these methods are more or less effective, and if applied under proper conditions curves of magnetization may be obtained, in which the rising and the falling lines coincide. The results obtained by the different methods, however, do not agree, as the curves can not be superimposed. The curve obtained for a steel wire by means of an alternating field having the same direction as the magnetizing field lies below that obtained when an alternating current is passed through the iron, and these two curves both lie below the curve obtained when magnetic oscillations are set up by means of a Tesla system. The results seem to show that the phenomenon usually designated as hysteresis is of a very complex character.—*Translated and abstracted from La Revue Electrique (Paris), June* 30.

The Tommasi Electrolyzer for Refining Copper.

The adaptation of the Tommasi electrolyzer, devised for refining lead, to the refining of copper, is here described by the inventor. It consists of a rectangular bath containing a solution of acidulated copper sulphate, to which are added certain compounds which are intended to reduce the resistance of the electrolyte, and which assist in causing a compact deposit of copper. In the bath two anodes of black copper are inserted. Between these is placed the cathode, which consists of a disc formed of a certain number of metallic sectors. This disc is attached at the centre to a shaft of aluminum bronze, which can be rotated readily. The different sectors of electrolytic copper, of which the disc is formed, are supported on a central disc having a rather smaller diameter. When the deposit of copper on these sectors has become sufficiently thick, they can be taken off and transferred to the casting furnace. The advantages of this arrangement are: polarization is entirely eliminated by the rotation of the cathode; the various sectors forming the cathode can be removed when the cell is not in operation, as at night; the copper deposit can be removed when sufficiently thick, without interrupting the work of the cell; the density of the electrolyte is maintained uniform at all parts, due to the stirring action of the rotating cathode. In operation, the cathode is revolved at from eighty to one hundred turns per minute. The current density is from one to two amperes per square decimetre. When the anode has been sufficiently dissolved, it can be removed without interrupting the cell.—*Translated and abstracted from L'Electrician (Paris), June* 25.

Preservative Treatment of Wood.

Various methods of treating wood, in order to prevent decay, are here considered somewhat critically by Dr. S. P. Sadtler. The structure of wood is first described, in order that the object to be attained by any treatment may be understood. Following this, the different methods are taken up somewhat in detail. None of these seems to the author to be entirely satisfactory, except the Ferrell system. In this the preservative, in liquid form, is forced into the wood at one end by hydraulic pressure, driving before it the sap until all has been expelled. The treatment is kept up until the preserving liquid issues from the other end. Escape from this end is then stopped and the pressure maintained. This forces the liquid to find its way out from the centre of the wood to the periphery by following the medullary rays and the saturation is completed. The whole process requires an average of not over nine minutes from the time pressure is applied until the liquid comes to the surface on the sides. This system is suitable for treating wood for all purposes, and has been developed for street railway ties, each tie being saturated individually. Any preserving material may be used, but it has been found that a mixture of aluminum sulphate with ferrous sulphate gives the best results. The wood is hardened without becoming brittle, and the preserving material does not leach out if the timber is properly dried.—*Abstracted from the Technology Quarterly (Boston), June.*

The Use of a Booster During Battery Discharge.

In this brief communication M. J. M. Gritters Doublet, manager of the central station at Groninque, Holland, describes the use of a discharging booster during the discharge of the battery, as has been used at his station, and which he believes improves the service of the system. When a battery is installed, controlled by the end-cell method, there are two disadvantages incident to this use—first, the regulation of the voltage can only be made in steps of two volts; second, there are always in the battery certain cells which are discharged less than the rest, and there are several cells which practically are never discharged completely. This tends to cause sulphating, so that when the cells are thrown into service, they have a diminished capacity. To avoid these inconveniences, M. Doublet regulates the pressure by means of his booster, keeping this in service constantly. When the voltage of the battery is too high, the booster acts as a motor, reducing the voltage to the desired amount, and, driving its motor as a generator, returns the energy absorbed by the booster to the system. In this way all of the cells are discharged similarly, and danger of sulphating is avoided. There is another advantage in this method when the generator and the battery are running in parallel. It is possible to regulate the output of each supply so as to obtain the most economical condition, and the booster acts as a balancer, tending to take any sudden fluctuations in the load. Records from recording voltmeters show that the station, operated in this way, gives a distinctly better service than when the booster is not used.—*Translated and abstracted from L'Éclairage Électrique (Paris), July* 2.

The Telephone in the United States.

This is a discussion by an Englishman, Mr. Herbert L. Webb, of the growth of the telephone in the United States and the reasons for it. He states that New York and suburbs, Brooklyn, and Boston and Chicago, where there are 325,000 telephones in use, together have an aggre-

gate population less than that of greater London, while they have in use a somewhat greater number of telephones than the whole of Great Britain and Ireland. Mr. Webb is much surprised at the rapid rate with which the use of the telephone is being extended, but is even more surprised that there is no apparent slackening in the rate of development. To explain this, the most important reason given is that there is no government monopoly of telephones in America. The telephone has here consequently escaped the blight of official interference, which has restricted its development in every European country. The author thinks that the telephone service in American cities as a general rule is excellent. The answer to a call is quick, and the work of completing the desired connection is rapidly and accurately performed. One important factor in the development of the telephone has been a policy which is distinguished by two main features—first, to bring the service to as high a pitch of perfection as possible; second, by means of educating the public to the use of the service, and by making rates calculated to appeal to all classes of the community, to create a demand for service so widespread as to be practically universal. One of the important factors in the first of these has been the general adoption of the central energy system. In the other, the adoption of the message rate instead of the flat rate has been the most important influence. In fact, it is since this method of charging was adopted by the New York company that the remarkable development began.—*Abstracted from Cassier's Magazine (New York), July.*

The Individual Motor Drive.

A critical study is here given of the application of the electric motor to driving single machines, particular reference being made to the machine-shop. The author, Mr. Robert T. Lozier, first explains the remarkable expansion of the electric drive. The advantages of driving by means of an electric motor first recognized were the saving in power due to a more economical system, and the saving in headroom, due to the abolishing of belts. The first of these items is of little importance practically, and the two together were not sufficient to bring about a general introduction of the motor drive. However, at the same time that this change in method was being urged, important developments were being made in general shop practice. The discovery of the air-hardened cutting steel, which could displace two or three and sometimes four times the metal which was cut off by the tool steels operating under old conditions, pointed the way to greater profits by increasing the output of the tools and the shop as a whole. The work thrown on the tools by these heavy cuts was greater than the old method of driving could stand, but for this purpose the motor drive was what was needed. This is the principal reason why the motor drive is becoming so popular, though there are other not unimportant advantages. The absence of belts gives free headroom for overhead cranes, and as individual tools are independent, they can be arranged more conveniently, with a saving of about twenty per cent in space. Mr. Lozier points out a particular instance where the changing over from the belt drive to the motor drive effected an increase in the output of the shop of about thirty per cent, and he gives figures to show just where the gain was made. The motor drive is not suitable for all machines. Those which occupy that part of the shop where a clear headroom is not necessary, and which run at a constant speed, and where the convenience of direct control is of little importance, do not warrant the change in method. On the other hand, those tools which it is desired to vary in speed, and those in which the convenience gained by the use of individual motors is important, do warrant the change. The various methods of obtaining a variable speed are taken up, and the conditions to be met are discussed. It is shown that in the case of a lathe, a speed ratio of the driving shaft of five to one is necessary. This gives the limits of general machine-shop practice. The question of the proper size of motor is also considered, but the rough rule that one horse-power will remove a cubic inch of soft steel in one minute, and that the average efficiency of the tool is not more than forty per cent, is thought to be unreliable.—*Abstracted from the Electrical Magazine (London), June.*

A New Process for the Prevention of Iron and Steel Corrosion.

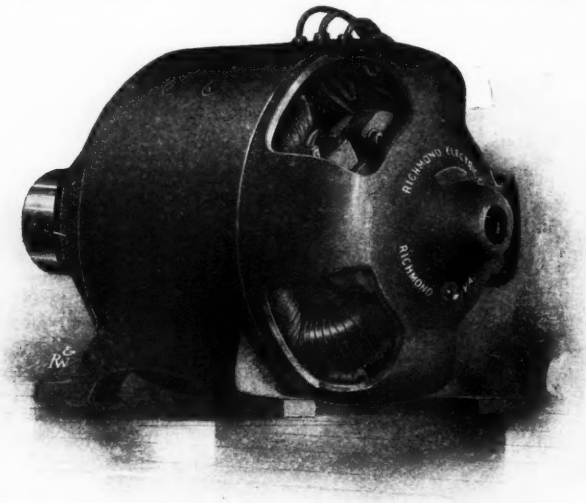
The method of coating iron and steel known as sherardizing is here described by the inventor, Mr. Sherard Cowper-Coles. This process effects the same result as galvanizing by either the hot or cold methods, but it is thought to be more convenient, cheaper, and to give a better coating. One point of particular interest about the new process is that iron and steel can be coated with an even deposit of zinc at a temperature several hundred degrees below the melting point of zinc. The first step in the process is to free the iron from scale and oxide by any of the well-known methods. The articles are then placed in a closed iron receptacle charged with zinc dust, which is heated to a temperature of from 500 to 600 degrees, turned for a few hours, and allowed to cool. Upon removing the articles, they are found to be coated with a thin homogeneous covering of zinc, the thickness depending upon the temperature and the length of time. The temperature required is about 200 degrees below the melting point of zinc, and this low temperature makes the process cheap as compared with the dipping process. It has the additional advantage that it does not deteriorate the iron or steel of small section to the same extent as hot galvanizing; and there is no loss of zinc dust. The process is not limited to the coating of iron with zinc, for it has been successfully applied to coating iron with copper, aluminum and antimony. It has also been applied to coating other metals, such as aluminum and copper, with zinc. Copper and its alloys, treated in this way, are case-hardened on the surface, and can be rendered so hard as to turn the edge of tool steel. The author describes the furnace used for this process, and gives a drawing of the suitable arrangement for a sherardizing plant. The zinc powder used in the process is the zinc dust of commerce, not zinc oxide. It is obtained during the process of distilling zinc from its ores. At the present time the price of this dust is a little less than that of virgin spelter. A minor advantage of the process is that it can be applied directly to articles covered with oil and grease, it not being necessary to cleanse them. The low temperature required is not high enough to affect the temper of steel wire, as is the case with hot galvanizing. Sherardized iron and steel are found to withstand the ordinary corrosive agents to which galvanized iron is exposed to a remarkable degree, even after the apparent removal of all the zinc by filing or abrasion; the iron is still non-corrosive. This is due to the protective action of the zinc alloy formed on the boundary line between the iron and zinc. Tensile tests of material treated in this way show that the process has no apparent weakening effect. The advantages claimed for the process, in addition to those already mentioned, are that less labor is required, since it is not necessary to clean the articles as carefully as in hot galvanizing; there is no flux necessary; no dross or skimming; there is no danger of explosion; sherarded machine work does not require refitting, as the coating is evenly distributed; the coating is more uniform than that given by other processes; there is no need to dry the article when taking it from the pickling vat; the process can be worked intermittently without waste; the coating can be made of any desired thickness, and the cost of a plant for applying this process is less than that for either wet or dry galvanizing.—*Abstracted from the Electrochemist and Metallurgist (London), June.*

INDUSTRIAL SECTION.

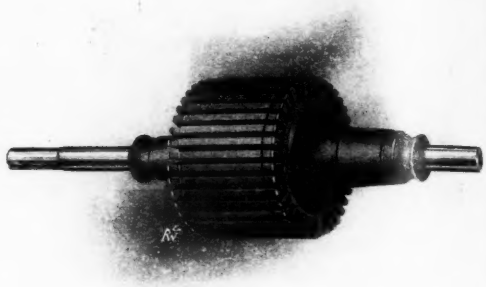
ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Slow-Speed Motors for Direct Current.

The Richmond Electric Company, Richmond, Va., has placed on the market a line of direct-current slow-speed motors, the design of which has been carefully worked out according to the experience of the manufacturers in many years of motor designing. The accompanying illustrations give a good idea of the various elements of this line of motors.

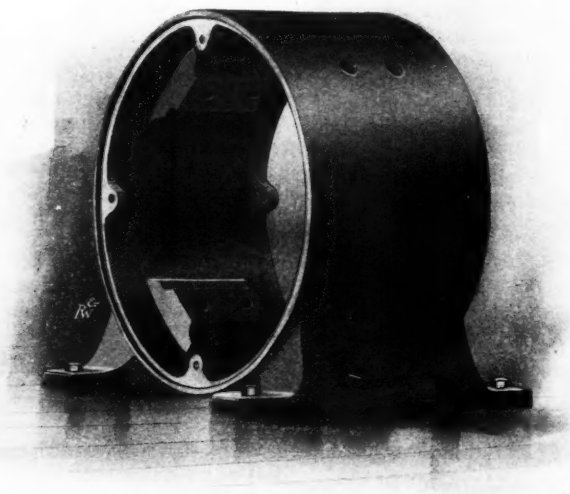


OPEN-TYPE, SLOW-SPEED MOTOR FOR DIRECT CURRENT.

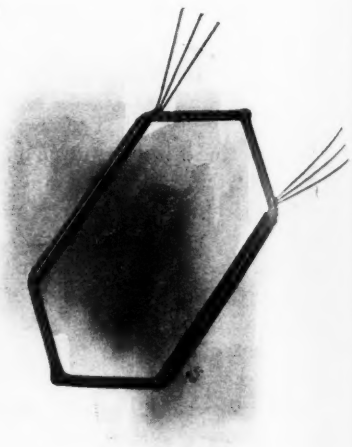


ARMATURE CORE.

The frames are of circular form, being made up of one solid casting of special steel of high permeability. The feet are cast onto the frame and stand well out, giving a good wide spread in every size. On the pulley end the holding down bolts come in line with the centre of the armature bearing. The spreading pole tips and short magnetic circuits tend to high efficiency.



CIRCULAR ONE-PIECE FRAME.



ARMATURE COIL.

The armatures are made of special sheet-steel, accurately punched, annealed, rolled and japanned. The segments are keyed upon the armature shaft and pressed together between malleable iron heads under heavy hydraulic pressure. The heads form in one piece the thrust collars and oil slingers, and being shrunk on, prevent the oil from creeping back along the shaft from the bearings and getting into the windings and commutator. The head of the commutator end forms a large taper on which the commutator shell fits. The commutator is held in place on this taper by a nut, which, in turn, is locked to prevent working loose.

The bearings are liberal in diameter and length, and the linings are one solid casting of aluminum bronze. Rings dipping into large oil chambers provide constant lubrication. A cleaning hole is provided at the bottom of the large oil chamber; an overflow at the side and a

cover permit ready access for inspection and filling.

The armature windings are composed of form-wound coils well insulated from each other, tested and assembled in groups. These groups are taped, dried and treated with varnish, and after being dried again are covered with insulation which is impervious to moisture. The coils are then pressed to exact shape and size in steam moulds.

The commutator leads are swedged into the commutator bars, and no solder, acids, or soldering compounds are used. The coils are form-wound and pressed, and are all exactly alike, and the winding being cylindrical, any coil can be easily removed and replaced. The coils are held firmly in place by steel band wires, which come below the surface of the core.

The field coils are carefully wound on forms, well taped, dried and varnished. The leads are flexible, of good size, and are securely fastened.

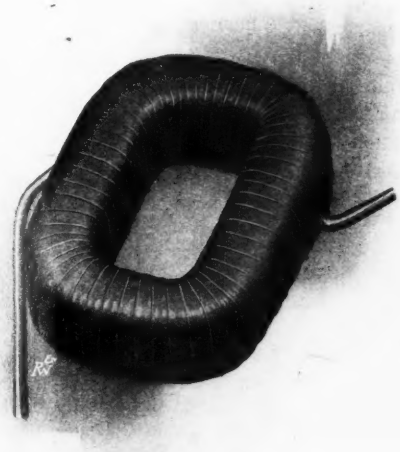
The pole pieces are built of punchings from high-grade electrical sheet-steel, carefully annealed, assembled and riveted together between end plates. All pole pieces are accurately fitted to the finished pole seats on the frame, and are held securely in position by steel cap screws. They are readily removable, and the projecting tips hold the field coils firmly in place.

The motor heads are cast in one piece and seat in counterbores in the frame, and are held in place by four cap screws. This arrangement permits the heads to be set into the frame with the feet downward, sidewise or upward. The motors thus lend themselves to use on floors, walls or ceilings.

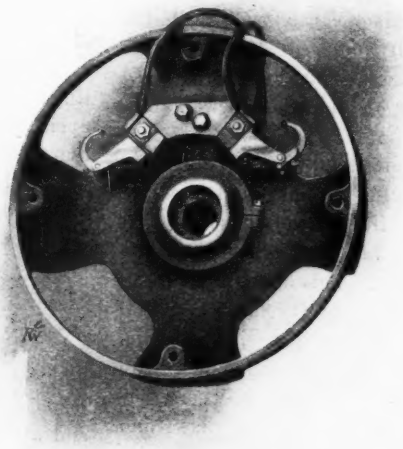
The commutators are built on malleable iron shells, which fit on the taper of the armature heads. Proper provision has been made for easy removal from the armature.

The brush-holders are of brass, and are of simple design and construction. In all sizes radial adjustment of holder is provided, so as to permit reduction of the commutator diameter without changing the angular distance between brushes. The carbon brushes slide in convenient ways, and the design is such as to ensure uniform pressure against the commutator during the entire life of the brush.

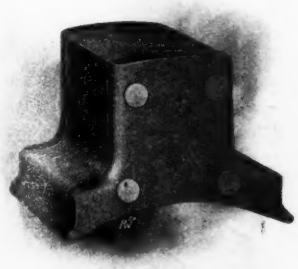
These motors are built fully enclosed or semi-enclosed. The same type of apparatus is made as direct-current generators up to twenty kilowatts, for the standard voltages from 100 to 500 volts.



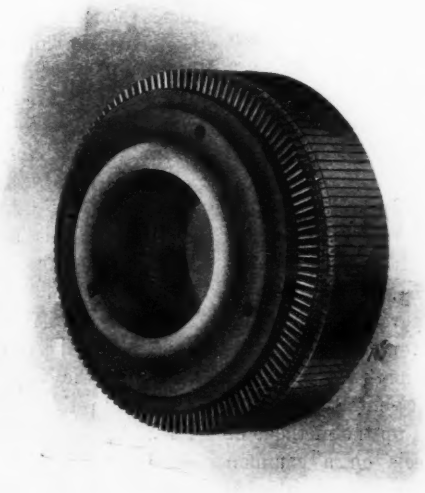
FIELD COIL.



MOTOR HEAD.



POLE PIECE.



COMMUTATOR.

Forms of Turbines Most Suitable for Low Falls.

At a recent meeting of the British Institution of Civil Engineers, a paper entitled "Forms of Turbines Most Suitable for Low Falls" was read by Mr. Alphonse Steiger. Attention was called to the character of water powers with low falls. These are seldom constant, as both the head of water and the flow are apt to vary. It is these variations which make the utilization of such water powers difficult.

By means of diagrams the difference between impulse turbines and pressure turbines was illustrated, showing what portion of the fall is used for producing pressure in each. This diagram indicates a means of adapting turbines to special requirements. While pure impulse turbines are not altogether condemned, there are but few places in England where they are preferable to pressure turbines; and even the Haenel turbine, which is an intermediate type between the pressure and impulse turbines, is not often suitable for English falls. The parallel-flow pressure turbine, often known as the Jonval, is particularly adapted to fluctuating falls. By using this turbine a constant speed may be obtained, without the sacrifice of efficiency. The paper described a recent installation of this type, and quoted results, to show that the part-gate efficiency of parallel-flow pressure turbines of this type is extremely good. An instance was given where radial outward-flow turbines were installed with a relatively low fall, and the manner in which a satisfactory efficiency was obtained was described.

The gate construction is an important factor in the design of turbines. Distinction should be drawn between gates intended for adjustment of the turbine to a varying load, where a high part-gate efficiency is of less importance than rapid regulation, and gates for adapting a turbine to varying conditions where a good part-gate efficiency is essential.

The paper also takes up the methods of grouping several wheels on a common shaft. A few instances were mentioned where the vertical arrangement had been adopted with advantage, as this allows the weight of the wheel to be balanced by the water pressure, and greatly reduces friction. In conclusion, attention is drawn to the need of studying more closely the conditions of water power with low falls, and of paying more attention to the adaptation of turbines to such falls. This, it is thought, will lead to a better appreciation of the water powers of England.

Industrial Education in Germany.

In a recent report, Deputy-Consul Ernst C. Mayer, at Chemnitz, Germany, describes somewhat fully the German system of education. This report takes up the various grades of schools, and follows the student in his progress through them. The first or the primary school has three parallel divisions, based on social and financial distinctions. At the tenth year an important age is attained, since at this time the student's parents must decide upon the general form of education which they desire their offspring to receive. This will be largely determined by the means of the parents and their position in life. The student may either continue at the primary school, or he may enter the secondary schools. These schools are either classical, semi-classical or non-classical, and in them the student is prepared for a higher education. The work of these schools extends through about six years, and after leaving, the student either enters the university or some industrial high school. The technical high schools invariably contain a number of closely correlated departments, and here the student specializes in his profession. Up to this time he has been preparing himself for a professional education, in that he has laid a broad foundation of general practical knowledge. During his work at the high school he is receiving the benefit of instruction in the most advanced technical thought that science and application have developed. These high schools stand side by side with the universities, of which they are at present the peers.

The Extra Service of the Large Allis-Chalmers Engine at the World's Fair.

The St. Louis Transit Company, which operates the larger part of the street car system in St. Louis, Mo., very soon after the fair opened found its plant overloaded in handling the large traffic which was attracted to the city. The railway company applied to the World's Fair authorities for additional power, with the result that Governor Francis and the fair administration have by contract put at the service of the railway company during the day, from 2 P. M. until 7 P. M., when the loads are heaviest, the output of the large Allis-Chalmers engine in the Machinery Building. This engine is coupled to a Bullock electric generator, and at seventy-five revolutions per minute, with a steam pressure of 150 pounds, operating non-condensing, is capable of developing 8,000 horse-power. From 8 P. M. until the fair grounds close, this unit supplies the current for the decorative lighting of the buildings and grounds. The lighting requires 200,000 incandescent lamps. The traction load which the engine and generator will now carry by contract between the railway company and the exhibition authorities will be at least 3,000 horse-power. This may be increased as the crowd is augmented.

American Institute of Electrical Engineers.

DIRECTORS' MEETING, NEW YORK, ASSOCIATES ELECTED WEDNESDAY, JUNE 15, AT 2 P. M., 1904.

Charles Francis Adams, Pittsfield, Mass.
I. Fraley Baker, East Orange, N. J.
Walter Vennard Batson, South Orange, Mass.
Henry Nicholas Bauer, Hasbrouck Heights, N. J.
Charles Edward Bennett, Pittsburg, Pa.
Clyde Albion Berry, New York city.
Charles Whitney Carman, Chicago, Ill.
Morris B. Carroll, Warwick, N. Y.
S. Waldo Coleman, Schenectady, N. Y.
Edgar Francis Collins, Schenectady, N. Y.
Nelson Wait Dalton, Thompsonville, Ct.
Earnest William Dean, Havana, Cuba.
Arthur W. Ferrin, Schenectady, N. Y.
John P. Fogarty, Columbus, Ohio.
John Drewry Foy, Birmingham, Ala.
Lawrence Lee Gaillard, New York city.
William R. Gardener, Pittsfield, Mass.
George Slocomb Gibbs, Boston, Mass.
Jonathan Monroe Gilmore, Pittsfield, Mass.
William Harper Glenn, Atlanta, Ga.
Ray Harrison Hadfield, Ames, Iowa.
William Hemphill, Buffalo, N. Y.
Truman Hibbard, Minneapolis, Minn.
Leonard Sherman Horner, New Haven, Ct.
Walter S. Jennens, Niagara Falls, N. Y.
Alfred Howard Jones, Atlanta, Ga.
Budd J. Jones, Chicago, Ill.
Charles Franklin Kettering, Dayton, Ohio.
Henry Nelms Latey, New York city.
John Henry Lawton, Ames, Iowa.
George Nelms Lemmon, Wilkinsburg, Pa.
Fritz Lowenstein, New York city.
Wilbur Emerson Mallalieu, Jersey City, N. J.
Richard McCulloch, St. Louis, Mo.
Benoni E. Mercil, New York city.
Charles Caldwell Morgan, New York city.
Anthony Saunders Morris, Philadelphia, Pa.
Alex Amerton Morton, Pittsfield, Mass.
Alexander Perry, Pittsfield, Mass.
Fred Alonzo Pielsticker, Carroll, Iowa.
Owen Baxter Playter, Seattle, Wash.
Hobart Rawson, Cincinnati, Ohio.
Alexander Hugh Scott, Ames, Iowa.
Hugh Gregorie Stokes, Early Branch, S. C.
Joseph Woodman Stover, New York city.
Jeremiah W. Sullivan, Buffalo, N. Y.
Robert I. Todd, Providence, R. I.
William Vincent Treeby, London, S. W., Eng.
Richard Carr Watson, New York city.
Amos Sheldon Weaver, West Lynn, Mass.
Edward Justus Wehrley, East Orange, N. J.
Victor Nugent Weidman, Pittsburg, Pa.
Alfred Williamson, New York city.
Harry LeVague Wills, Kirkwood, Ga.

ASSOCIATES TRANSFERRED TO THE GRADE OF MEMBER.

John C. Barclay, New York city.
Albert S. Richey, Anderson, Ind.
Philip Torchio, New York city.

Electric Locomotives for Gathering Purposes.

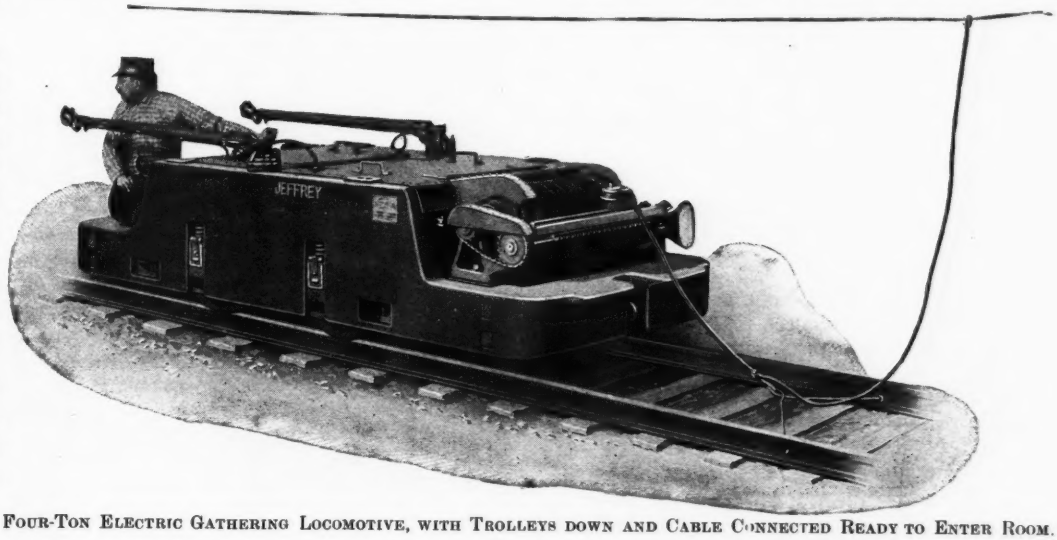
The Jeffrey Manufacturing Company, Columbus, Ohio, is probably one of the best-known manufacturers of mining machinery in the country. This company has had particular success in adopting electricity for various forms of mining machinery, and its electric locomotives are in use in collieries all over the world.

The accompanying illustrations show a line of electric locomotives for gathering purposes which this company has placed upon the market. These locomotives are made in different sizes, and are equipped with either one or two motors, depending upon the weight of the locomotive.

The distinctive feature of this gathering locomotive is that it may be operated over tracks where there is no trolley wire nor steel rails. This is made possible by carrying upon the locomotives a reel of flexible insulated conductor. When it is desired to run on tracks where there is no trolley wire, the cable is connected to terminals provided for the purpose, and the locomotive is propelled by current taken through the cable. The cable is automatically paid out as the locomotive runs away from the terminals and automatically rewound in even layers and with uniform tension upon the reel when the locomotive returns. The locomotive is always provided with a standard trolley for use on portions of the haulage system where there is a trolley wire. A double-throw switch connects the motor to either the trolley or the cable circuits. All of the electric contacts and conductors are enclosed in dust-proof compartments, so that it is impossible for the attendant to touch them unintentionally.

The cable reel and spooling device are mounted at one end of the locomotive, on top of the end frame. This construction gives ready access to the motors, and also permits the total height of the locomotive to be made as low as possible. Locomotives of this style are manufactured with a total height as low as twenty-nine inches.

The insulation of the flexible conductor which is wound upon the reel is made of the best quality rubber, well protected from mechanical injury by heavy braidings. This cable is of sufficient length to permit the locomotive to reach the greatest depth of rooms found in mining practice. The cable may have either single or twin conductors. The single-conductor cable is used when the tracks in the rooms are laid with steel rails. In such cases the rails must be bonded or connected so as to form a continuous length, to ensure a good return circuit.



FOUR-TON ELECTRIC GATHERING LOCOMOTIVE, WITH TROLLEYS DOWN AND CABLE CONNECTED READY TO ENTER ROOM.

The reel is turned by a friction clutch, which is driven by a silent-running chain and sprocket from the motor. The control of the clutch is placed within easy reach of the attendant at the operating end of the locomotive.

The general features of this type of locomotive are shown in the accompanying illustrations. The locomotive frame is of cast iron, and is constructed in four pieces—two side frames and two end frames, securely held to the side frames by means of large bolts. The locomotive is provided with spring suspensions, being supported by helical springs made of spring steel. These springs are mounted between the tops of the journal boxes and the frames, where pockets are provided to hold them in place. The journal boxes are constructed in accordance with the specifications of the Master Car Builders' Association, and are of the most improved pattern, with large oil wells and ample room for packing. They are fitted with lumen bronze metal bearings, of such dimensions that the weight per square inch of bearing surface does not exceed 250 pounds. The driving wheels

FOUR-TON ELECTRIC GATHERING LOCOMOTIVE, WITH OUTSIDE WHEELS.

are of the best grade of cast iron, with chilled treads. The wheels are keyed and pressed on the axles. The axles are made of the best quality of hammered open-hearth steel.

The brake mechanism is of efficient design, quick, effective and convenient for application. The mechanism is so constructed that the minimum amount of power applied gives the greatest braking effect.

The motors are especially designed for mine service. They are of the four-pole enclosed type, and are dust-proof. The capacity of the motors is so proportional to the weight of the locomotive that they will exert enough power to slip the wheels, should the motor be overloaded.

In the controller is embodied the magnetic blowout principle, preventing arcing at the contacts when the controller is operated. The controller is provided with an operating and reversing cylinder. The resistance used in connection with the controller for starting the locomotive has a large current-carrying capacity and is made of a special composition of resistance ribbon, wound in coils mounted on non-combustible insulators made of lava.

The trolley pole is clamped at its lower end in a socket, and is hinged on a swivel base. A helical spring, located in the trolley base, forces the pole upward so as to make proper contact pressure between the trolley wheel and wire. When not in use, the trolley pole is held down by an automatic locking device.

The sand boxes are cored in the side frames and connect to sand pipes which drop the sand directly in front of the wheels. The locomotives are provided with electric headlights well protected by cast-iron hoods.

The National Electric Light Association.

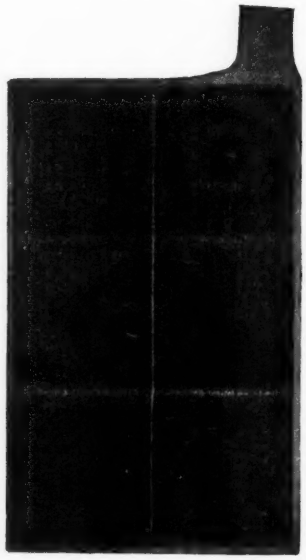
The many questions and answers which made up the Question Box at the recent twenty-seventh annual convention of the National Electric Light Association have been issued in printed form. They form a volume of 473 pages, containing a vast amount of information on practical subjects, much of which will not be found anywhere else. The volume is supplemented with an authors' index, a topical index of questions, and an alphabetical index of questions. It has been edited by Mr. H. T. Hartman.

Annual Meeting of the Colorado Electric Light, Power and Railway Association.

The annual meeting of the Colorado Electric Light, Power and Railway Association will be held at Colorado Springs, September 21, 22 and 23, 1904. The office of the secretary, Mr. George B. Tripp, is at Colorado Springs, Col.

Electric Vehicle Type Storage Batteries.

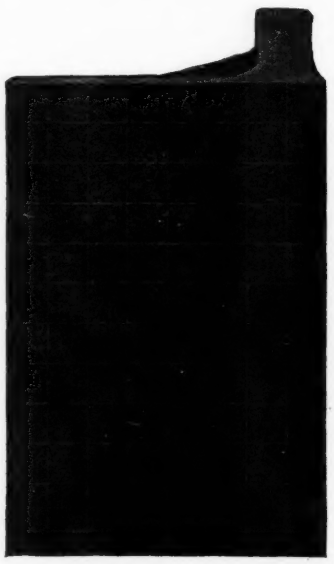
The Gould Storage Battery Company, No. 1 West Thirty-fourth street, New York city, has placed on the market a new form of electric vehicle type storage



VEHICLE TYPE POSITIVE PLATE.

battery known as the "E. P." The positive plate is made of pure lead, subdivided by the well-known Gould "spinning" process, giving an increased surface ratio of twenty to one, and is electrochemically formed.

The negative plate is of the pasted type,



VEHICLE TYPE FORMED NEGATIVE PLATE.

and is made to withstand both the electrical and mechanical shocks incident to electric vehicle work. The separation used is perforated hard-rubber sheets against both positive and negative plates, with centre spacing ribs, doing away with all danger of short-circuits and allowing ample acid space and circulation.

This combination of a Planté positive and pasted negative is giving very excellent satisfaction in life. It has been found that the use of such a positive reduces to a minimum the necessity for frequent cleaning of the cells, as the amount of peroxide or active material on the positive plate is not of sufficient quantity to fill up the bottom of the cells to any appreciable extent.

The use of such a combination also has the advantage of enabling a recharge to take place at high rates, if required, without increased deterioration of the plates.

The accompanying illustrations show

VEHICLE TYPE CELL, COMPLETE.

the manner in which these cells are constructed. A typical cell, containing nine plates five and seven-eighths by eight and one-quarter inches, has outside dimensions as follows: width, four and one-quarter inches; length, six and one-quarter inches; height, ten and three-quarter inches. The weight of the cell complete is thirty-two and one-half pounds.

In charging these cells, the charge is started at the four-hour rate plus twenty per cent, and charging is continued at this rate until the cells read 2.5 volts per cell. The current is then allowed to fall until twenty per cent of the charging rate is reached, when the charging is complete.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

NEW LOUISIANA ELECTRIC LINE—The Bayou Teche Electric Company, which has for its object the building and operating of an electric railroad from New Iberia to Berwick, and the supplying of light and power to a large section of country, is to be organized at an early date in New Orleans, La. The corporation is being promoted by Gen. F. F. Myles, and it is announced that practically all of the $1,000,000 of capital has been secured, the franchises granted, and the route located.

NEW YORK CENTRAL TO MAKE ARRANGEMENTS FOR AN EXPERIMENTAL TEST OF ELECTRIC LOCOMOTIVES—A third-rail system is to be installed for a stretch of six miles between Schenectady and Hoffman's, N. Y., by the General Electric Company and the New York Central & Hudson River Railroad Company. The system is for the purpose of testing electric locomotives which are to be used on the Hudson River division of the railroad from the Grand Central station to a point thirty-five miles north.

TELEPHONE COMPANY TAKES ON LARGE MORTGAGE—A first trust mortgage of the Commercial Union Telephone Company to the Troy Trust Company, as trustee, was filed under date of July 1 in the office of the county clerk at Ballston Spa, N. Y. The mortgage is for $1,000,000, and is given to guarantee the payment of $1,000,000 on bonds issued by the telephone company. The mortgage is based on the stock, franchises, central offices, etc., of the former Rensselaer Telegraph and Telephone Company and the Saratoga Telegraph and Telephone Company, consolidated by recent deeds.

PENNSYLVANIA TROLLEY MERGER—A deal has been closed in Uniontown, Pa., whereby John R. Byrne, of Everson, with Uniontown and eastern capitalists, has secured control of the charter, property, stock and franchises of the Brownsville, Bridgeport & West Side Street Railway, the Brownsville & Uniontown Street Railway, the West Brownsville & Washington Street Railway, and the Brownsville Junction & California Street Railway. It is the intention to merge the four companies with a capital of $1,000,000. The work of building lines in Brownsville and Bridgeport, and from Brownsville to Uniontown, will be commenced at once.

NEW YORK CENTRAL TO OPERATE A LONG-DISTANCE PRIVATE LINE—It is announced that a private telephone wire 1,000 miles long is being erected along the New York Central Railroad system from New York to Chicago. No. 8 copper wire will be used, and the line will touch every important city on the lines of the New York Central system. The officers of the company believe that the large expense of constructing and maintaining this private telephone line will be more than justified by the convenience and promptness of intercommunication between eastern and western divisions of the company. It will save a large amount of money in telegraph and telephone tolls, besides preserving strict privacy.

CHANGE OF OWNERSHIP OF THE SCHENECTADY RAILWAY COMPANY—It is announced that the negotiations for the purchase of the Schenectady (N. Y.) Railway Company by the Delaware & Hudson and the New York Central & Hudson River Railroad systems have ended successfully. The Schenectady Railway Company is one of the most important in upper New York, and its 100 odd miles of track is in excellent condition. The franchises of the company are perpetual. The Schenectady Railway Company controls all the street railway and electric light business of Schenectady, holding the stock of the Schenectady Illuminating Company and the Mohawk Gas Company. It is probable, however, that the steam railway company will not acquire the lighting companies.

CHICAGO CAPITALISTS TO BUILD INTERURBAN RAILWAY IN NEBRASKA—Chicago capitalists have organized a company to build and operate a large interurban electric railway system in the state of Nebraska. The project has been incorporated under the laws of that state, and will be known as the Omaha & Nebraska Central Electric Railway. The line will be 200 miles long, and will extend from Omaha to South Omaha, and in a westerly direction to Millard, Wahoo, David City, Osceola, Stromberg, Arborville, Aurora and Hastings. It will carry passengers, mail and freight, and will be constructed standard gauge. It will be equipped with high-speed cars of modern construction, sixty-five feet long, and there will be a public telegraph and telephone service in connection with the road. Work will begin immediately, and the ambition of the projectors is to have it in operation within a year.

AUTOMOBILE NOTE.

THE ST. LOUIS RUN OF THE AMERICAN AUTOMOBILE ASSOCIATION—The following persons have been received as entrants for the St. Louis run of the American Automobile Association, which will be held between July 25 and August 10, under the auspices of the touring committee: Harlan W. Whipple, Andover, Mass.; John Farson, Chicago, Ill.; C. H. Gillette, New York city; Windsor T. White, Cleveland, Ohio; Elliott C. Lee, Boston, Mass.; A. R. Pardington, Brooklyn, N. Y.; J. A. Chase, Pawtucket, R. I.; W. E. Milbank, Albany, N. Y.; Augustus Post, New York city; Frank X. Mudd, Chicago, Ill.; W. C. Temple, Pittsburg, Pa.; R. P. Scott, Baltimore, Md.; Charles J. Glidden, Boston, Mass.; William Monypeny, Jr., Columbus, Ohio; H. W. Smith, Syracuse, N. Y.; George S. Waite, Cleveland, Ohio; James L. Breese, New York city; F. C. Donald, Chicago, Ill.; H. Frederick Lesh, Boston, Mass.; Thomas B. Jeffery, Kenosha, Wis.; A. J. Wills, Akron, Ohio; Haynes-Apperson Company, Kokomo, Ind.; Hart D. Newman, New Orleans, La.; Royal R. Sheldon, Boston, Mass.; R. E. Rolfe, Boston, Mass.; Paul H. Demming, New York city; George H. Lowe, Boston, Mass.; Ray D. Lillibridge, New York city; Webb Jay, Cleveland, Ohio; Cecil P. Wilson, Boston, Mass.; A. R. Pendleton, St. Louis, Mo.; W. E. Metzer, Detroit, Mich.; F. N. Manross, Forestville, Ct.; E. H. Wallace, Freeport, Pa.; Matheson Motor Car Company, Ltd., Holyoke, Mass.; F. A. LaRoche, New York city; G. Douglas Neare, Cincinnati, Ohio; John K. List, Wheeling, W. Va.; William J. Morton, New York city; George Otis Draper, Hopedale, Mass.; H. H. Franklin Manufacturing Company, Syracuse, N. Y.; W. B. Saunders, Philadelphia, Pa.; Sam Stone, Jr., New Orleans, La.

OBITUARY NOTICES.

MR. WILLIAM A. BUTLER, a prominent citizen of Syracuse, N. Y., died on the morning of July 10, after an illness of more than a year. Mr. Butler was born in Syracuse in 1851, and lived in that city all his life. He was graduated from Cornell University in 1869, and three years later secured his degree of civil engineer from the same institution. He obtained employment with the engineering corps of the Lackawanna Railroad, and later did considerable city work and was employed by a number of other railroad companies. He was one of the organizers of the Pierce, Butler & Pierce Manufacturing Company, which was established in 1876. He was also one of the organizers of the Syracuse Lighting Company and the Steam Heat and Power Company.

THE HON. THOMAS OLIVER, a former mayor of Lockport, N. Y., and one of the most successful manufacturers in the upper part of New York state, died at his home in Lockport, on the evening of July 10. Mr. Oliver was a sincere advocate of municipal ownership, and achieved considerable notoriety about 1890 by his efforts to secure the city ownership of the lighting plant. He was born in Albany, N. Y., sixty-eight years ago, and early in life began in the manufacturing business at Cohoes. He went South with his brothers, engaging in the cotton mill business. In 1878 he went to Lockport with William Oliver, his brother, and built a mill on Pine street. He was one of the original directors of the Niagara, Lockport & Ontario Power Company, resigning quite recently from the directorate.

TELEPHONE AND TELEGRAPH.

GALVESTON, TEX.—A telephone line is to be constructed from Markham to El Campo.

MINNEAPOLIS, MINN.—A telephone line will be built from Ada to Lockhart and Betcher.

FARGO, N. D.—A telephone line is being built from White Earth south to the Missouri river.

SPRINGFIELD, TENN.—The Cumberland Telephone Company will install an exchange at Greenbrier.

CHARLOTTE, N. C.—The Charlotte Telephone Company has passed into the hands of the Southern Bell Telephone Company.

SOUTH CHARLESTON, OHIO—The Home Telephone Company has strung a new circuit to South Charleston, and also one to Springfield.

POUND, WIS.—The town board has granted a franchise to the Farmers and Merchants' Telephone Company to build a line through the town.

PASCAGOULA, LA.—The American Telephone and Telegraph Company is constructing additional lines between Montgomery and New Orleans.

BLACKSHEAR, GA.—The Southern Bell Telephone Company is making arrangements to install a local exchange, and will commence work at once.

BEAUMONT, TEX.—The Diana Brick and Tile Company is arranging to build an independent telephone line from its works at Concord to this city.

KEENE, N. H.—The New England Telephone Company is to construct new trunk lines from Keene to Concord, Worcester, White River Junction and Brattleboro.

SCOTTSBORO, ALA.—A transfer of the property of the Stevenson Telephone Company has been made to the Southern Bell Telephone Company. Many improvements are to be made.

PHILADELPHIA, PA.—Arrangements have been completed for the installation of a wireless telegraph system between Wilkesbarre and Scranton. The system to be used is that of a local inventor.

ROCK ISLAND, ILL.—The Moline board of education has awarded a contract to the Union Electric Telephone Company for the installation of telephones in the public school buildings of the city.

WHEELING, W. VA.—The Fairmont Telephone Company has installed a line between Morganstown and Cheat Haven, giving connection with Uniontown and the various parts of Fayette and Greene counties.

READING, PA.—The consolidated Telephone Company has decided to extend its lines to West Reading and Mount Penn Borough, and work will commence at once. The West Reading line will be extended to Wyomissing.

DUBUQUE, IOWA—The Western Union Telegraph Company contemplates making extensive improvements in this city in the near future, and it is estimated that $20,000 will be expended. Work will commence about the middle of August.

EGG HARBOR, N. J.—The Egg Harbor City Telephone Company has opened its exchange here with seventy-five subscribers. The company is composed of business men of this city, and is local as well as long-distance. G. W. Otto is president.

RED CREEK, N. Y.—A franchise has been granted to the Wayne-Monroe Telephone Company to construct its lines in Red Creek and operate an exchange. The village will shortly have connection with Fair Haven, Fulton, Oswego, Syracuse and the eastern part of the state.

LINCOLN, NEB.—The Farm and Home Telephone Company, of Newport, has incorporated with a capital stock of $5,000. The company will operate a telephone line between the town of Simpson, in Keya Paha County, and Anoka, Boyd County. The incorporators are C. M. Thompson and G. E. Van Every.

MARIETTA, OHIO—The consolidation of the West Virginia Western Telephone Company and the Marietta Telephone Company has gone into effect, the West Virginia company assuming charge of the business of the Marietta company. The formal transfer has not been effected, and probably will not be for one or two months.

CORVALLIS, ORE.—The Independent Telephone Company now has an office in Corvallis, and there is regular communication with Philomath and the farmers' line north of the town. Progress on the local system is going on rapidly, and it is expected to have the work completed before the summer is over. Many farmers' lines are also being constructed throughout the county.

BALTIMORE, MD.—The stockholders of the Union Telephone Company have elected these officers for the ensuing year: C. L. Almony, president; S. S. Van Trump, secretary-treasurer and manager; Dr. W. Millard Stirling, James P. Jordan and G. G. Winemiller, executive committee. The capital stock of the company will be increased and the lines extended to Freeland and to Bradenbaugh.

UTICA, N. Y.—The Utica Home Telephone Company is preparing to put in 8,000 feet of underground cable, and is equipping its switchboard so as to accommodate 800 additional subscribers. When the company opened for business, on April 1 of last year, the number of subscribers was 1,300, and at the present time the number is 3,100. The Rome Independent Telephone Company is also making improvements to meet its increasing patronage. Two new sections will be added to the switchboard and 20,000 feet of aerial cable will be strung. The company has at the present time 1,100 subscribers.

STERLING, ILL.—The farmers' mutual telephone companies of Tampico and vicinity have merged into one company incorporated under state laws. At a meeting of fifty of the shareholders, a board of seven directors was chosen and officers elected. The board of directors consists of the following: Charles Emory, Will Smith, Myron Bush, A. O. Hunter, E. A. Emmons, Otto Nelson and E. Cummings. L. A. Wheelock was elected president; Otto Nelson, secretary, and E. A. Emmons, treasurer. The new company embraces all the farmers' lines merging at the central at Tampico, including the Prophetstown and Rock Falls lines.

HARTFORD, CT.—At a meeting of the directors of the Southern New England Telephone Company it was voted to increase the capital stock of the company by issuing 5,000 new shares of stock at a valuation of $500,000, which will bring the capitalization up to $1,500,000. Before the end of the year another 5,000 shares will be issued, which will bring the capitalization of the company up to $5,000,000, the amount authorized by the charter. The new stock will be sold at par to stockholders, and at the ratio of one new share for each eight shares of the old stock. It will be payable August 15 and will share in the October dividend.

COLFAX, IND.—The American Telephone and Telegraph Company, with headquarters at Chicago, has secured right of way for a trunk line from Chicago to Indianapolis, and construction has been begun. There are nearly one hundred men employed, and they are placing poles and cross-arms in position for an eighty-wire system at the rate of four miles a day. The line will follow the old State road as nearly as possible through Indiana, and while it will be within easy access of several towns, no service will be given to intermediate points save La Fayette. A representative of the company states that it expects to have the work completed by November 1.

MONMOUTH, ILL.—At the annual meeting of the stockholders of the Monmouth Telephone Company, held at Monmouth recently, the reports of the officers showed the company to be in a flourishing condition. It has been in operation three years and has 998 telephones in service, 711 of which are in this city. The other 287 are used in the country service. The report showed receipts to the amount of $12,609.65, the operating expenses being $6,808.60. Of the balance, $3,000 was paid as interest on the bonds. The net balance of $2,801.05 will be used for the extension of the business and various improvements. The following officers were chosen for the ensuing year: president, C. C. McClung; vice-president, J. E. Lanphere; treasurer, H. B. Smith; manager and secretary, W. J. McQuiston.

VIRGILINA, VA.—The Virgilina Telephone Company held its annual meeting at Virgilina on July 1. The secretary's report showed that about fifty miles of line are now in operation, and that extension has been made to South Boston, Va. The old officers—Evan Davis, of High Hill Mine, president; W. W. Tuck, of Virgilina, Va., general manager, and J. B. Wilborn, secretary and treasurer—were re-elected. After declaring a semi-annual dividend of three per cent, the remaining surplus and $500 in new stock were appropriated to extend the line from High Hill to Buffalo Springs, Va., and to make the circuit a metallic one. By making this extension connection will be had at Buffalo Junction with the Home Telephone Company, of Henderson, N. C., which has over 4,000 telephones in operation. The Virgilina company has installed the latest type transmitters and receivers, and will also install a new switchboard.

ELECTRIC LIGHTING.

HAWARDEN, IOWA—The electric light plant is to be improved and repaired at a cost of $6,000.

OMAHA, NEB.—The electric light plant at Fremont will be enlarged so as to permit of a day service.

NORWICH, CT.—A check for $190,000 has been given by the city to the gas and electric company. The plant will hereafter be under municipal control.

JUNCTION CITY, CAL.—The North Mountain Power Company is rushing work on its line to Eureka, and hopes to have it completed before the coming winter.

COLUMBIA, TENN.—The Columbia Water and Light Company has received and put in place the machinery recently ordered for its plant. This is capable of supplying 3,000 lights.

DANVILLE, PA.—The contract for erecting the municipal electric light plant has been awarded to the Rumsey Electrical Manufacturing Company, of Philadelphia. It aggregates about $15,000.

NEW YORK, N. Y.—At the annual meeting of the stockholders of the Butte Electric and Power Company, the old board of directors was reelected. There were 19,123 shares of stock represented, out of a total of 25,000.

DANVILLE, ILL.—The village of Fairmount is to have an electric light system. It is said that a franchise will be granted to prominent Fithian citizens, who will install an up-to-date plant before the close of the present summer.

NEWBERRY, S. C.—Newberry will install a new electric lighting plant. The council has adopted a resolution authorizing the mayor to execute notes amounting to $4,700, payable in two equal payments at six per cent interest, in payment of the plant.

REDDING, CAL.—The new power-house of the Northern California Power Company at Kilarc has been placed in operation. Current at 20,000 volts is transmitted to the Afterthought mine, owned by the Great Western Gold Company, and also to Bully Hill.

RICHMOND, VA.—An ordinance is to be introduced in the common council providing for a bond issue of $300,000 in four per cent thirty-four-year bonds. The money to be raised by this means will be used in the construction of an electric light and power plant.

EUREKA, CAL.—Station A of the Eureka Lighting Company's plant has been destroyed by fire, entailing a loss of $20,000. The property was owned by the Pacific Coast Gas and Lighting Company, of San Francisco, and will immediately be rebuilt on a larger scale.

FREELAND, PA.—G. B. Markle & Company contemplate making extensive improvements to their electric light plant at Jeddo, which, when completed, will enable the company to extend their line to Highland and Ebervale, in which towns arc lights are to be installed.

PATASKALA, OHIO—A. G. Fields, of Columbus, is at the head of a company that proposes to put in an electric light plant at Pataskala that will not only furnish illumination for this place, but for Jersey, Summit Station, Etna, Kirkersville and Outville. Such a plant would cost $200,000.

SANTA CRUZ, CAL.—A project is on foot to saddle the San Lorenzo river for the purpose of furnishing power for the Co-operative Light Company. The power-house will be located at Rincon Flat, and the water will be carried from the dam to the power-house and discharged again into the channel.

SEATTLE, WASH.—The Seattle Electric Company is now securing power from its new plant at Electron, on the Puyallup river. Only one generator is at present in service, this producing 5,000 horse-power. Three other generators are in process of installation, which will give the plant an output of 20,000 horse-power for this city and Tacoma.

SAN FRANCISCO, CAL.—Articles of incorporation of the Humboldt County Water and Power Company have been filed with the secretary of state by B. von Homeyer, N. H. Hine, F. B. Hink and J. G. Levern. The company's plans cover a power plant in the city of Eureka and the diversion of water from Mad river. A reservoir will be built between the point of diversion and Eureka, and at that point a vast amount of power will also be developed, so that the city plant will be used only as an auxiliary one. The city plant will be installed at once to supply all customers during the construction of the reservoir and diversion of the water.

CUMBERLAND, MD.—The Potomac Light and Power Company has been incorporated by G. Tayloe Blackford, of Baltimore, and G. M. Botchford, William MacL. Somerville, Alfred T. Wilson and Lloyd Lowndes, Jr., of Cumberland. The capital stock is $50,000. The company has applied to the mayor and city council for a franchise. A suitable site has been secured and work will be commenced on the erection of the plant after the franchise is granted.

WINSTED, CT.—A company in which Winsted and New Hartford capitalists are interested will shortly be formed to generate electricity at Pleasant Valley in the town of Barkhamsted. The intention is to transmit power for lighting and power purposes to surrounding towns. Options on needed land and water rights are now being obtained. A dam two hundred feet long will be built and a storage reservoir covering fully two hundred acres of land will be developed.

ALBANY, N. Y.—Articles incorporating the Middleville Electric Light Company have been filed with the secretary of state. It is proposed to manufacture electricity for lighting the streets and buildings in Middleville, and the towns of Fairfield, Newport and Herkimer, Herkimer County, and also for power purposes. The capital stock is placed at $4,000, and the directors for the first year are as follows: Lewis H. Goodman, David E. Ford and Anna M. Goodman, of Middleville.

FREDERICK, MD.—The Frederick Gas Company and the West End Gas and Electrical Company, of Frederick, were merged into one company here recently, under the name of the Frederick Gas and Electrical Company. Articles consolidating the companies have been recorded in the clerk's office, with the following incorporators and directors for the first year: Jacob Rohrback, Charles P. Levy, Charles Wertheimer, Edwin C. Markell, Dr. Sollers, S. Maynard, Thomas H. Haller, of Frederick; Francis K. Carey, of Baltimore; Charles L. Serrill and Robert C. Cookman, of Philadelphia. The capital stock will be $200,000. The articles authorize the issuance of 250 gold coupon mortgage bonds at five per cent, which shall be paid at the expiration of twenty-five years.

ROSSLAND, BRITISH COLUMBIA—Rossland men are behind the Chilliwack Power and Light Company, now seeking municipal franchises in Chilliwack. The concern is capitalized at half a million, and proposes to expend $100,000 in developing electric power and light on Vedder creek, six or seven miles from the market, which will be at Chilliwack. Among those interested are Charles M. Oliver, Harry McIntosh, Thomas Stout, Wilfred Elley, E. G. Conroy, E. Charles Rose and W. R. Braden. J. Burtt Morgan is the promoter of the company, and is managing the affairs of the concern at Chilliwack. On Vedder creek the company will develop a fine water power, and transmit electrical energy to the town for power and lighting. It is stated that enough contracts have been secured in advance to permit of the payment of dividends from the start. In addition to the power project, the company has a tramway system in view.

CHEHALIS, WASH.—At a special meeting of the city council the city electric light plant and franchise were leased to Harry West, the present lessee, for a term of fifteen years, beginning December 21 of this year. According to the terms of the lease, West is to provide a 300-horse-power alternating current; to furnish the city the first year fifteen 2,000-candle-power arc lights, increasing gradually to twenty-four the fourth year; after that an arc light will be added for every increase of 300 in population, also thirty-one sixteen-candle-power incandescent lights are furnished free for the use of the city. The minimum charge for private service will be $1 per month. The meter rate is not to exceed twelve and one-half cents per kilowatt-hour, with discounts for quantity and hours of light to make the rate as low as six cents per hour. If Mr. West's present plans are carried out, he will move the plant to Littell, four miles west of Chehalis, where an abundant supply of cheap fuel can be obtained.

ELECTRIC RAILWAYS.

FINDLAY, OHIO—John Dunn has secured a franchise for an electric road from Casino to Point Place.

SYRACUSE, N. Y.—The Marcellus & Otisco Lake Railroad is extending its line from Marcellus to Marietta.

DETROIT, MICH.—Work on the new electric line to connect this place with Saginaw will commence at once.

CANONSBURG, PA.—The Washington & Canonsburg Railway Company is preparing to extend its line to East Canonsburg.

MEMPHIS, TENN.—Promoters are said to be seeking a right of way for an electric line between Clarksdale and Friars Point, Miss.

LINCOLN, NEB.—Estimates on the Omaha-Lincoln-Beatrice interurban railway place the cost at between $35,000 and $40,000 a mile.

AURORA, ILL.—The Aurora, DeKalb & Rockford Electric Traction Company has commenced work on its new line from Aurora to DeKalb.

ROCKVILLE, MD.—Arrangements have been made for the entrance of the Washington & Rockville Electric Railway Company's road into Rockville.

NEW WINDSOR, COL.—A fifty-year franchise has been granted by the town board to the Northern California Electric Railway Company, work to be commenced within one year.

NORFOLK, NEB.—It is thought certain that an electric railway will be built between Anoka and Springview, Neb., before the end of the year. C. A. Johnson, of Butte, Mont., is interested in the project.

ALMONT, MICH.—It is stated that the prospects for the construction of an electric railroad from Romeo to Almont are very bright. The survey has been completed, and the right of way is now being secured.

HACKENSACK, N. J.—The Public Service Corporation has acquired a site for a new power-house in North Bergen, to be used to furnish power for the Jersey City, Hoboken & Paterson Street Railway's line to Hackensack and Paterson.

CHATTANOOGA, TENN.—S. W. Divine has been granted a franchise by the county court to construct the lines of his Ducktown electric railway over certain streets and roads in Hamilton County. Work must be started within six months.

WEBB CITY, MO.—It is reported that a movement is on foot to build an electric railway from Carthage to Joplin, with a branch to Neck City, Purcell and Alba, *via* Oronogo. The new line, as proposed, will shorten the distance between the two cities almost thirty minutes.

OAKLAND, CAL.—It is stated that the East Shore & Suburban Company, which is building the new Point Richmond electric railway system, is about to extend its line to connect with that of the Transit company, which already runs to the northern line of Alameda County.

JEFFERSON CITY, MO.—The secretary of state has issued a charter for the St. Joseph Interurban Railway Company, of St. Joseph. The company has a capital stock of $100,000, which is held by George C. Simms, Alice Butler, Samuel F. Moore, James E. Patrick and John J. Lea.

EVERETT, WASH.—The county commissioners have granted a trolley franchise to P. J. Farley, as trustee, for a trolley line from Everett north to Skagit County, going by way of Marysville, Silvana, Florence and Stanwood. The road will connect with the Seattle & Cherry Valley line at Everett, and its northern terminus will be Mount Vernon.

PORTLAND, IND.—The Portland, Montpelier, Warren & Huntington Traction Company has about completed the work of securing its right of way between this city and Pennville, and announces that the construction contract will shortly be let through the Municipal Bonds and Securities Company, of New York, which has financed the project.

SPOKANE, WASH.—It is stated that the Adams County electric road will be in operation between Davenport and Miles by the fall. One of the plans of the electric company is to develop the water power at the mouth of the Spokane river, and a location has already been made upon these rapids. It is claimed that sufficient power can be secured from this source to run the electric line, not only to this city, but to points in Adams County as well.

BROCKPORT, N. Y.—G. Tracy Rogers, of this city, has purchased the Buffalo, Hamburg & Aurora trolley road for the sum of $78,000. The road is about fifteen miles long and connects the three places mentioned in its name. Mr. Rogers has also bought the Buffalo, Gardnersville & Ebenezer road, four miles long. It is understood that he is interested in these transactions with a syndicate composed of New York and Binghamton capitalists.

READING, PA.—H. E. Ahrens & Brother have been awarded a contract to reconstruct the entire line of the Mohnsville & Adamstown Railroad and the Reading & Southwestern, a distance of about fifteen miles. It is expected to have the work completed in about sixty days. The line between Mohnsville and Adamstown is to be entirely reconstructed, and that between Reading and Mohnsville will be widened. This will practically give Reading a through line to Lancaster.

McDONALD, PA.—The Carnegie, McDonald & Canonsburg Street Railway Company has applied to the borough council of McDonald for a franchise. The company agrees to begin construction within one year and to complete the road within three years. It is also stated that as soon as all the right of way has been secured, work will be commenced on the line, which is to extend from Carnegie through Oakdale to McDonald and then to Canonsburg *via* Cecil and Bishop.

PERSONAL MENTION.

MR. W. H. SCHOTT, of Chicago, has been elected president of the Kewanee, Cambridge & Geneseo Electrical Railway Company.

MR. SAMUEL T. HOWE has been appointed manager of the Topeka, Kan., exchange of the Bell Telephone Company, succeeding R. B. Gemmell.

MR. PAUL M. MOWREY, vice-president of the Engineering Company of America, New York city, is making a business trip to Europe, where it is expected he will be for about five weeks.

MR. JOHN H. BUCKLEY, Yonkers, N. Y., has prepared a very useful metric conversion table of linear measure. In this the values of metres from 1 to 100, and millimetres from 1 to 1,000, are given in inches, the latter being carried to four decimal places.

MR. ALEXIS LE BLANC, an electrical engineer attached to the staff at the United States Army Building, New York city, is said to be working on a new form of dirigible balloon. It is understood that work is now under way, and that the apparatus is being constructed by a New York firm.

MR. J. E. PEAVEY has been appointed superintendent of the exchanges of the Cincinnati & Suburban Telephone Company, to take the place of Mr. William B. Bentley, resigned. Mr. Peavey is well known in telephone circles, and has contributed several articles to the more prominent technical journals.

MR. MELVIN SAUNDERS, of Saginaw, Mich., has been appointed manager of the Valley Telephone Company, in Bay City, Mich., to succeed Mr. E. G. Pike, who has accepted the position of district superintendent of the Southwestern Telegraph and Telephone Company, with headquarters at Houston, Tex.

MR. F. J. NEWTON has been appointed general foreman of the wire and cable department of the General Electric works at Schenectady, N. Y. Mr. W. C. Hayman has been appointed assistant. The former incumbent of the office which Mr. Newton will take charge of is connected with the sales department of the company.

MR. B. L. FREEDY, manager of the St. Paul (Minn.) exchange of the Northwestern Telephone Company for ten years, has been appointed general superintendent of the company at Minneapolis. He will be succeeded in St. Paul by R. H. Woolfolk, of the Stillwater exchange. C. P. Donnelan, of St. Paul, will take charge at Stillwater.

MR. A. L. WATERBURY, at one time first vice-president and general manager of the Citizens' Telephone Company, of Houston,

Tex., has accepted a position as general manager of the sales department of the American Conduit Company. Mr. Waterbury will have his headquarters at the Chicago office of this company, 1005 Manhattan Building.

MR. THOMAS E. MURRAY, second vice-president and general manager of the New York Edison Company, while going to his home in Brooklyn last week with Mrs. Murray, was thrown from his automobile and both he and Mrs. Murray were painfully bruised. The accident occurred because of the breaking down of one of the front wheels while the machine was under way.

DR. SCHUYLER SKAATS WHEELER, president of Crocker-Wheeler Company, Ampere, N. J., electrical manufacturer, sailed last week with Mrs. Wheeler on the White Star liner Baltic. He has planned a coaching trip in England. Early this spring Dr. Wheeler went on an automobile tour through the south of France and returned with the American patent rights of the world-celebrated electrical firm, Brown, Boveri & Cie., of Baden, Switzerland.

DR. F. A. C. PERRINE has resigned as first vice-president of the Stanley Electrical Manufacturing Company, at Pittsfield, Mass., and has been succeeded by Mr. C. C. Chesney, formerly chief engineer of the same company. It is Dr. Perrine's intention to continue his engineering work in the particular line of power transmission where his ability and experience have already won him great distinction. Mr. William W. Gamwell, treasurer of the Stanley company, has also resigned.

MR. HARRY R. KING, designing electrical engineer of the Western Electric Company, of Chicago, Ill., was married on June 21, at Leadville, Col., to Miss Irene Baker. Mr. and Mrs. King will remain in Colorado for their honeymoon, spending the next few weeks in the mountains near Rifle. Mr. King has been connected with the engineering department of the Western Electric Company for several years, during which time he has formed a very wide acquaintance among electrical interests.

MR. LOUIS TERVEN, E. E., University of Wisconsin, has recently been appointed chief electrician of the Nernst Lamp Company, Pittsburg, Pa. Mr. Terven was for some time electrician of the United States navy yard, Port Royal, S. C., which position he resigned to enter the experimental laboratory of the Nernst Lamp Company. Later he was given charge of the chemical engineering department of the company. A second promotion in so short a time speaks well for the engineering ability of Mr. Terven.

MR. ARTHUR H. REYNOLDS, a well-known British railroad engineer, is making a tour of the United States, investigating American railway construction. While in Los Angeles last week Mr. Reynolds is quoted as follows in the San Francisco papers: "Electricity is bound to open up fields of competition, and in this era it seems to me that the California fruit grower will see the day of prosperity finally dawn. Electricity will pave the way for a thorough system of roads from the East to Los Angeles, and with the wonderful facilities of this section, with millions of gallons of water unconserved as yet, waiting to turn electric generators, I do not think that the day is far distant when Los Angeles will be the metropolis of the southwest."

LEGAL NOTE.

LITIGATION ON THE PATENTS COVERING THE PROCESS OF EXHAUSTING INCANDESCENT ELECTRIC LAMPS—It has been announced that suits have been commenced against the Moline Incandescent Lamp Company, of Moline, Ill., by the General Electric Company, for infringement of United States letters patent No. 537,693, dated April 16, 1895, and No. 726,293, dated April 28, 1903, respectively. These two patents cover the process of exhausting incandescent electric lamps, and are known to the trade as the "chemical exhaust" patents. It is understood that the defendant, in the manufacture of incandescent lamps, is practising the process of exhausting lamps covered by these patents.

ELECTRICAL SECURITIES.

On Thursday of last week there was the first reaction to what has been a steadily advancing market. This came about because of exaggerated reports of the damage which had been suffered through wind and storm by the heretofore much-favored wheat crop. This showed, too, how important a factor the crop really is. There is, however, a strong undercurrent of bullishness, and the tendency still seems upward. A development of the week that has had an important influence upon sentiment is the broadening of the stock market. Dealings have been active, commission houses have reported a notable improvement, and the investment demand for high-grade securities and bonds has shown no signs of the setback which some operators have predicted ever since the turn of the half year. The fact that many professional traders have contested the advance is by no means a cause for discouragement or bearishness. Expert opinion is that the short interest is still large, and this is a guarantee that a further advance will bring these shorts into the market as buyers. It is a significant fact that while trading opinion is mixed it still is bullish as to the future. Bear operators confine their pessimistic predictions almost solely to the immediate future, and admit that when crop and political uncertainties are removed—especially if harvests are gathered in anything near the volume now indicated—a bull market is ahead for the autumn months.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JULY 16.

New York:	*Closing.*
Brooklyn Rapid Transit	50⅜
Consolidated Gas	194¼
General Electric	164
Kings County Electric	190
Manhattan Elevated	151
Metropolitan Street Railway	116½
New York & New Jersey Telephone	147
Westinghouse Manufacturing Company	164

It is announced that the Brooklyn Rapid Transit Company has effected the sale of $5,000,000 four per cent convertible and refunding gold bonds.

Boston:	*Closing.*
American Telephone and Telegraph	130
Edison Electric Illuminating	245
Massachusetts Electric	74
New England Telephone	122
Western Telephone and Telegraph preferred	87½

The directors of the Edison Electric Illuminating Company have declared the regular quarterly dividend of 2½ per cent, payable August 1.

Philadelphia:	*Closing.*
Electric Company of America	9
Electric Storage Battery common	58
Electric Storage Battery preferred	58
Philadelphia Electric	6
Union Traction	54
United Gas Improvement	86

Electric Company of America directors have declared the semi-annual dividend of 3 per cent, payable July 30.

Chicago:	*Closing.*
Chicago Telephone	120
Chicago Edison Light	142
Metropolitan Elevated preferred	55
National Carbon common	28
National Carbon preferred	102
Union Traction common	4¼
Union Traction preferred	29

The Lake Street Elevated's adjourned annual meeting ratified the last contracts of the reorganization plan and adjourned to September 27.

The Chicago city council has passed an ordinance for the extension of the Northwestern Elevated Railroad to Ravenswood; also an ordinance declaring the street car lines of the old Chicago Passenger Railway, a subsidiary of the Union Traction Company, forfeited, and ordering bids from new companies to operate.

INDUSTRIAL ITEMS.

THE INDIANA RUBBER AND INSULATED WIRE COMPANY, Jonesboro, Ind., has presented some of its patrons with a handsome lithographed wall card bearing its advertisement.

THE AUTOMATIC VENTILATOR COMPANY, 39 Cortlandt street, New York, illustrates and describes in a booklet which it is distributing the car ventilators which it manufactures.

THE NORTHERN ELECTRICAL MANUFACTURING COMPANY, Providence, R. I., will be pleased to send its new leaflet, No. 131, on request. This leaflet describes and illustrates the application of Northern motors in blowing and ventilating service, operating blowers and fans.

THE AUTOMATIC SWITCH COMPANY announces that the office and works have been removed to the old address at 131 Liberty street, New York city, where the business will be continued under the management of the following officers: David H. Darrin, president; Frederick G. Townsend, secretary-treasurer.

SHUTTE & KOERTING COMPANY, engineer and machinist, Philadelphia, Pa., is sending out a circular letter describing the "Schutte" automatic free-exhaust and back-pressure valve, together with a circular illustrating the valve. The company is also sending a circular illustrating and describing the "Schutte-Koerting" eductor condenser.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., has recently had published a revised eighth edition of "Graphite as a Lubricant." This publication contains much interesting information in connection with graphite and its application. Copy will be sent on request. The company has also sent out a large postal card describing its axle lubricant.

THE GARVIN MACHINE COMPANY, Spring and Varick streets, New York city, will be pleased to send its complete catalogue, descriptive of metal-working machine tools. This catalogue not only describes in detail the different apparatus, but also gives carefully worked illustrations. A carefully prepared index makes it easy to find any particular piece of apparatus.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., is calling especial attention to its "Continental" lamp. This company is the general western agent for Helios-Upton enclosed arc lamp. The "Continental" lamp is fitted with a direct-current choke coil fully protected by patents, and the company claims that because of this coil the lamp will give thirty to forty per cent more candle-power than the ordinary direct-current multiple arc lamp.

THE ELECTRIC GAS LIGHTING COMPANY, Boston, Mass., is distributing a number of bulletins and mailing cards describing its telephone apparatus. This company is the manufacturer of the "Samson" straight-bridge transmitter and auxiliary apparatus for both long-distance and intercommunicating telephone systems. The company is also the popular manufacturer of a large variety of annunciator and plug-boards, hotel call-boards and fire-alarm systems.

THE D. & W. FUSE COMPANY, 407-409 Pine street, Providence, R. I., has secured a large contract from the Manhattan Elevated system of the Interborough Rapid Transit Company, New York city, for cutouts and fuses for heavy service. This order has been delivered, and the fuses are in operation. There are in use four fuse boxes on each car. The order was placed with the D. & W. Fuse Company entirely on merit, after submitting its fuses in competition with those of other manufacturers. The tests given were, it is said, of the severest nature.

G. M. GEST, the expert subway contractor, Cincinnati and New York, has been awarded the complete installation of an underground conduit system, including all the electrical distribution to service and house connections, for the South Bend Electric Company, South Bend, Ind. This work covers all of the main streets of that city, and will be one of the most complete and modern conduit systems so far constructed. The work is to be completed at the earliest possible moment, and a large force of men will be employed at once. The Oliver Chilled Plow Company has a private plant at South Bend, and has contracted with Mr. Gest for the construction of its underground conduit system. Mr. Gest has also been awarded a contract by the Toronto Railway Company, Toronto, Canada, for the construction of its underground subway system, covering all the main thoroughfares of the city of Toronto.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., is distributing a handsome bulletin describing the power of the intramural, the electric generating plant of the intramural railway at Machinery Hall, World's Fair, St. Louis. This bulletin is being used to advertise the principal exhibit, seven railway-type generators installed by the Crocker-Wheeler Company. The combined capacity of these units is 3,500 kilowatts. In addition to the illustration of the engines and generators there is a map in color of the Louisiana Purchase Exposition.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, 32 Cortlandt street, New York city, has published its revised catalogue No. 18. This illustrated catalogue and price list covers every conceivable form of electrical supply. The company handles specialties for electric light, household, telephone, telegraph and railway engineers. A feature of the catalogue is a list number index, which, to any one familiar with the ordering system of the company, is very valuable. The general index is carefully arranged and very complete. On the whole, the book forms a valuable contribution to the literature of engineering.

FRANK H. STEWART, trading under the firm name of Frank H. Stewart & Company, announces to the trade and customers of that firm that he has sold out the business carried on by him to "Frank H. Stewart Electric Company," a Pennsylvania corporation with a capitalization of $50,000 preferred stock, and $50,000 common stock. The new business will be conducted with Frank H. Stewart as president of the company, and associated with him will be those who have long been connected with the old firm. All bills will be paid and all collections made from this date (July 7) by Frank H. Stewart Electric Company. The headquarters of the company will be at Philadelphia, Pa.

THE WEST SHORE RAILROAD is distributing some timely literature concerning its service to St. Louis. Among the interesting views are typical scenes of the region en route to and from the World's Fair. The "Continental Limited" runs over the Niagara Falls route, passing over the famous Wabash railroad, known as the "Banner Route." This train will be one of the features of the World's Fair travel. It is composed of vestibule cars throughout, with baggage, combination smoking and day coaches, Pullman sleeping and stateroom cars, and an excellent dining-service car is attached. Souvenir menu cards are a feature of this service. At this time of the year, when vacations are in order, the company's attractive literature concerning the Catskill Mountains and resorts reached by the West Shore Railroad and connections will be of value. A recent folder which has been produced gives a very fine map of the region on either side of the Hudson river between New York and Albany, including the Catskill Mountains. In addition to this map there are given complete lists of excursion rates and addresses of boarding houses, with terms, etc. Mr. C. E. Lambert, 7 East Forty-second street, New York city, is the general passenger agent.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., has recently closed contracts for installations of chloride accumulators for the following railways: with Westinghouse, Church, Kerr & Company, engineers for the Long Island Railroad Company, Hammil, L. I.; Portsmouth, Dover & York Street Railway, Dover, N. H.; California Gas and Electric Corporation, for the Petaluma & Santa Rosa Electric Railway of California; Toledo Railways and Light Company, Toledo, Ohio; the City Railway Company, Dayton, Ohio. Contracts have also been closed for lighting and power service with the Mutual Life Insurance Company, New York city; Central Oil and Gas Stove Company, Gardner, Mass., and residence plants for Mrs. A. N. Kendle, Lamoille, Ill.; Mrs. C. E. Bates, Dalton, Mass. Westinghouse, Church, Kerr & Company have ordered over 2,000 cells of chloride accumulators for use in train lighting on the New York, New Haven & Hartford Railroad Company and over 600 cells have been ordered for the Atchison, Topeka, Santa Fe Railway Company for signal service. Increases have been made in the plants of the Lancaster Traction Company, Lancaster, Ohio; the Danver, Champaign Railway Company, St. Joseph, Ill.; the Danville Street Railway and Light Company, Georgetown, Ill., and Rochester Railway and Light Company, Rochester, N. Y.